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EDITORIAL.

MATTERS THAT MATTER.

THERE are questions which will never receive a satisfactory answer, problems which can never receive a rational solution, some things whose very nature precludes more than speculation for which the mind of man seems inadequate, hopes deferred whose realisation will never be reached; to compile such a list were an easy task. Ancient minds put many recondite questions, some, like "the way of a bird in the air," have been answered; but others, more intangible, of Greek and Hebrew origin, cannot be solved because of human limitation. There are, however, enough puzzles left, after the elimination of these, to provide exercise for statemanship and wisdom, outside even the field of politics, whose solution would be beneficial if it is not quite imperative to provide remedies.

The average man is unconcerned as to the ultimate constitution of matter, rather indifferent to speculative philosophy, the riddle of the universe may not trouble him in the least; what does raise his interest to a keen edge is the eternal problem of bread and butter. He will pay scant attention to the basic questions of existence, but rouses to immediate attention on the subject of subsistence. The one is speculative theory, the other practical politics; life's aftermath is a future matter, meanwhile he has to live. Talk of the ultimate exhaustion of coal you leave him cold, stint his winter's fuel so that he feels cold in actuality and he grows hot with indignation; one is problematical the other practical. Huge sums may be spent carelessly from the national treasury with small protest, indeed, with the fullest approval if he benefits; start taxing on an adequate scale to meet the charges and he squeals and curses.

Such is human nature, and all the evolution since prehistoric days has not amended some of its salient features. The trouble is that even now man in bulk is not rational, so many want to reap where they have not sown, something for nothing has always found plentiful approval. The fact of past mishandling is insufficient excuse for present arbitrary demand based upon illogical reasoning. A great deal has been said as to the complementary side of duty; cutting the coat according to the available cloth has always been an approved counsel of prudence. We are passing through a time of stress, a probationary period linking two distinct ages; old things have passed away, it yet remains to make all things new. The revolution proceeding is the most stupendous ever known, the potent danger is that the reversal shall go too far, it is the well-known swing whose amplitude is proportionate to its previous status.

Fortunately there are signs of commonsense appearing on the horizon, and stability will be reached none too soon; the dawn is chilly, but there are signs of light. The rake's progress has been slowed if not entirely arrested, sanity is returning, the practical is taking the place of the speculative, and efforts are being made towards a resumption of the common round and daily task.

The matters that matter are bread and butter considerations, the war machine has been checked, the peace machine is arriving, liquidation and reconstruction are proceeding simultaneously; the old firm may have changed its methods and management, but the essential basis of industry remains unaltered. Forged on the anvil of the past, toughened by the necessities of the war, the renaissance pending should give an unequalled recuperation to the future;

the return to duty should allow free play to capacity, as in earnest we tackle the matters that matter.

The chief objective is stimulation of effort; it is possible to let dire poverty exert its own discipline, but much better to avoid it. Conservation of natural resources is now a paramount necessity, cheeseparing can save something, but nursing the national estate has immediate and future benefit. Thrift is an odious term to some, it may or may not be a virtue, but it will shortly be involuntary. Wastage in every shape and form must be ruthlessly excised, circumstances will exert their own compulsion, cheerfully met it will be easier than if enforced. Youth must be given its chance and age provided for; there are also those who suffered on our account and in our stead, a perpetual charge upon the community.

To shirk burdens like these is unworthy of a great tradition, the bills they represent must be met without squealing, to lift a dead load is perchance the least enjoyable of all tasks, but if slow—it is the effort that counts. So long as we are corporate members of a free community, we neither live or suffer alone; it is comparison which hurts, difference which divides, individual unshared hardship that really matters.

Economic questions arise,it is useless to burke their incidence, folly to dismiss patent facts, stupidity to have no thought for the morrow; wealth is won in terms of effort and by no other means. During the war many lessons were impressed industrially, the country placed upon its mettle with the urgent need of necessity for stimulus, performed the miraculous, turned ploughshares into guns, and by united effort alone was victory made possible. Methods and processes got severe revision, the advantages of more scientific production received a startling emphasis, and while peace production cannot compare in many respects, yet, is the fullest advantage being taken to preserve a similar spirit in regular work? Have the discoveries been fully applied, or are they to lapse with the resumption of the normal? There is often a disposition to blame the national policy which has to be framed in the interests of all, when the fault lies nearer home; to require special privilege when effort and intelligence in partnership would solve the vexed impediments to the release of industry, give a rational life to all, repay debt and secure the future.

It is of course folly to expect miracles either productive or otherwise, everything has to be toiled for, even release from toil; leisure can only be afforded in terms of effort, the task can be shortened by willing hands and stout hearts, it can be prolonged to the verge of actual and irremediable disaster short of these factors. Recovery from a surgical operation involves a long period of convalescence, such a period must be slow; industry is to-day in a like case, but with all allowance made, it is high time we set our house in order for the new tenants—capacity and knowledge.

Grits and Grinds for August, the house journal of the Norton Company, Worcester, Mass., U.S.A. This interesting journal deals almost exclusively with questions on grinding. An article dealing with the important part that grinding plays in the manufacture of tractor parts appears in the August issue, accompanied by a useful table giving detail of machines employed, wheels used, stock removed, and production per hour.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Continued from Vol. VII., page 350.)

The General Theory of Leaf Springs.

Had we followed the usual sequence, the general theory of leaf springs, of which the larger part of the present paper is an exposition, would have been treated in our first paper, but, for reasons already stated, the actual complexity of this apparently simple subject indicated that it would be advisable for us to discard custom in order to gain clarity, hence our first paper was written so as to give the reader greater confidence in the mathematical generalisations which follow.

If a leaf spring be so constructed that each leaf is in contact with its adjacent one along its entire length, but without pressure—when in the unloaded, or "free" condition—then, on the application of a load, one of three things may happen. First, the leaves may separate everywhere except at the tips and at the centre point of encastrément; second, the leaves may continue in contact everywhere but without pressure except at the tips; and third, the leaves may tend to foul one into another, so that there will be pressure acting between the leaves for a greater or lesser part of their length.

Our first paper dealt with the first condition, which is

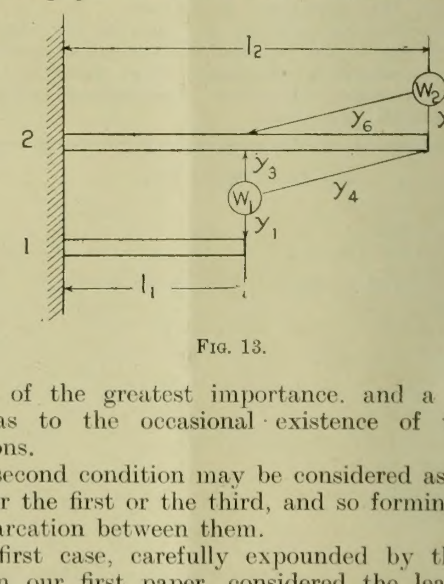


Fig. 13.

usually of the greatest importance, and a hint was given as to the occasional existence of the other conditions.

The second condition may be considered as the limit of either the first or the third, and so forming the line of demarcation between them.

The first case, carefully expounded by the theory given in our first paper, considered the leaves when subjected to load to remain in contact only at the centre point of encastrément and at the tips of the leaves; most of the commercial springs, especially those of the cheaper grades, and of the heavy springs used by the railways, fall into this class.

The second case will be examined from the point of view of it being the limiting case of the first—it is not of much actual importance, but still requires to be considered in order to make the study complete.

The third case is not of common occurrence in practice, nevertheless it is becoming more so, and may occur either through design or through accidents of manufacture. It is of considerable importance, and will, therefore, be considered in due course.

With these preliminary remarks we now proceed to establish the generalisation of our theory in as simple a manner as possible. For convenience we will first consider the two lower plates of a spring.

Referring to Fig. 13, the load on the end of plate No. 1, or the reaction between plates Nos. 1 and 2, is W_1. The load on the end of plate No. 2 is W_2.

Considering the bottom plate, No. 1, the load W_1 acting on it will produce a downward deflection which we will denote by y_1, and we may write:

$$y_1 = A_1W_1$$

where A_1 is a coefficient which may be calculated when we know the section everywhere of plate No. 1.

Now, considering the second plate, the reaction W_1 acting at the distance l_1 will produce an upward deflection, say y_3, at the distance l_1, and we may put:

$$y_3 = A_3W_1$$

where A_3 is a coefficient which may be calculated when we know the section everywhere of plate No. 2.

Similarly, the load at W_2 acting on plate No. 2 at the distance l_2 will produce a downward deflection at l_1 which we may denote by y_6, and we can thus write:

$$y_6 = A_6W_2$$

where, again, A_6 is a coefficient which may be calculated when we know the particulars of the second plate.

Next, considering the equilibrium of the two plates, it is at once seen that:

$$y_1 = y_6 - y_3$$

or:

$$A_1W_1 = A_6W_2 - A_3W_1$$

from which:

$$\frac{W_1}{W_2} = \frac{A_6}{A_1 + A_3}$$

giving the ratios of the loads or reactions W_1 and W_2.

We must next note that for the second leaf, the reaction W_1 acting at the distance l_1 will produce an upward deflection y_4 at l_2, and we may write:

$$y_4 = A_4W_1$$

where A_4 may be calculated.

Similarly, the load W_2 acting at l_2 will produce a downward deflection of y_5 at l_2, and we have:

$$y_5 = A_5W_2$$

where again A_5 is a coefficient which may be calculated.

The total actual deflection then of the two-plate spring at l_2 due to the load W_2, which we shall denote by Y_2, is evidently

$$Y_2 = y_5 - y_4$$

or:

$$Y_2 = A_5W_2 - A_4W_1$$

The reasoning, unfortunately, is not too easy, although a careful study of the foregoing, with the aid of the diagram, will show that the question is merely one of equating to equality the upward and downward deflections of the plates, which are produced by the various forces.

Having indicated the method of procedure as applied to the two bottom leaves, we proceed to the general case, and for this we refer to Fig. 14. It is to be understood that the y's (small y's) refer to the deflections of the individual plates, considered apart from the spring as a whole, and the Y's (capital Y's) refer to the deflection of the "partial springs," thus:

y_{4n} is the upward deflection of the $n+1$th leaf at l_{n+1} due to the reaction W_n at l_n;

y_{4n-1} is the upward deflection of the $n+1$th leaf at l_n due to the reaction W_n at l_n;

y_{4n-2} is the downward deflection of the nth leaf at l_{n-1} due to the reaction W_n at l_n;

y_{4n-3} is the downward deflection of the nth leaf at l_n due to the reaction W_n at l_n:

Y_n is the downward deflection of the partial spring of n plates at l_n due to the reaction W_n at l_n.

Now let:

$$y_{4n-a} = A_{4n-a}W_n \quad \ldots\ldots (9)$$

$$Y_n = B_nW_n \quad \ldots\ldots (10)$$

and

$$W_{n-1} = C_{n-1}W_n \quad \ldots\ldots (11)$$

then a consideration of the equality of the deflection of the plates at the points of contact shows that:

$$y_{4n-2} - y_{4n} = Y_{n-1}$$

or

$$A_{4n-2}W_n - A_{4n-5}W_{n-1} = B_{n-1}W_{n-1}$$

from which we obtain:

$$\frac{W_{n-1}}{W_n} = C_{n-1} = \frac{A_{4n-2}}{B_{n-1}+A_{4n-5}} \quad \ldots\ldots (12)$$

We also note that:

$$y_{4n-3} - y_{4n-4} = Y_n$$

or:

$$A_{4n-3}W_n - A_{4n-4}W_{n-1} = B_nW_n$$

from which:

$$B_n = A_{4n-3} - A_{4n-4}C_{n-1} \quad \ldots\ldots (13)$$

and these equations give the fundamental relations between the deflections of the individual leaves,

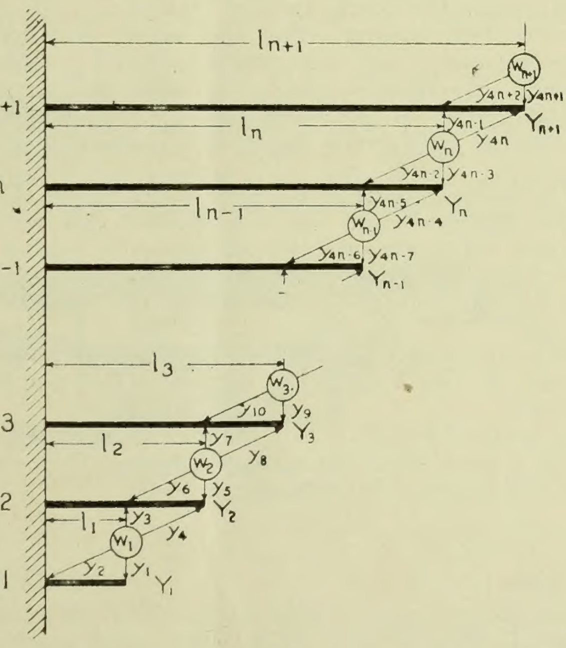


Fig. 14.

those of the partial (and complete) springs, and the ratios of the various reactions.

It must be noticed that A_2 (the deflection coefficient for the bottom plate at the encastrèment) is always zero, and that B_1 (the deflection coefficient of the partial spring of one plate only) is always equal to A_1.

The complete relations of a spring can now be calculated, starting at the short plate, called No. 1, and working upwards, as is explained more fully in the succeeding paragraphs.

The A's can all be calculated independently, for they depend solely on the individual details of the various plates: these calculations for various cross-sectional variations of the plates will be dealt with fully in a later section of this paper, and for the moment we will assume that all the A's have been determined.

Note that $B_1 = A_1$.

Then put $n=2$ in equation (12), and we obtain:

$$C_1 = \frac{A_6}{B_1 + A_3}$$

from which C_1 can be calculated.

Then put $n=2$ in equation (13), and we obtain:

$$B_2 = A_5 - A_4 C_1$$

from which B_2 can be calculated.

Having now calculated C_1 and B_2, put $n=3$ in equations (12) and (13), giving:

$$C_2 = \frac{A_{10}}{B_2 + A_7}$$

and

$$B_3 = A_9 - A_8 C_2$$

from which C_2 and B_3 are obtained.

Proceeding in a similar manner will give the deflection and reaction coefficients for the complete spring. The work is somewhat tedious, but not difficult, and, after a few springs have been calculated out, it will easily be seen that the work of arithmetical computation can be systematised so as to minimise the actual amount of labour. It must be admitted, however, that the labour of working out completely, say, a ten-plate "graded" * spring is very considerable, and in practice, where many springs have to be calculated out, a calculating machine is certainly a desirability—almost a necessity.

The above exposition contains the complete theory of the deflection and reaction relations for all leaf springs, which are such that the leaves do not tend to foul into one another, and therefore covers, as previously mentioned, the great majority of commercial springs.

We now proceed to details, and show how the values for the A's for the various plates are to be derived.

In general terms, if y is the deflection at the distance x from the point of encastrèment, then using the well-known relation:

$$\frac{d^2y}{dx^2} = \frac{M}{EI} \qquad \text{(14)}$$

we have:

$$E\frac{dy}{dx} = \int_o^x \frac{M}{I}\,dx \qquad \text{(15)}$$

$$E\,y = \int_o^x \int_o^x \frac{M}{I}\,dx\,dx \qquad \text{(16)}$$

* A "graded" spring is one whose leaves are not all of the same thickness.

and it is seen at once that:

$$\frac{E}{W_n} y_{4n-3} = \int_o^{l_n} \int_o^{l_n} \frac{l_n - x}{I_n}\,dx\,dx \qquad \text{(17)}$$

$$\frac{E}{W_n} y_{4n-2} = \int_o^{l_{n-1}} \int_o^{l_{n_1}} \frac{l_n - x}{I_n}\,dx\,dx \qquad \text{(18)}$$

$$\frac{E}{W_n} y_{4n-1} = \int_o^{l_n} \int_o^{l_n} \frac{l_n - x}{I_{n+1}}\,dx\,dx \qquad \text{(19)}$$

and also:

$$y_{4n} = y_{4n-1} + (l_{n+1} - l_n)\frac{dy}{dx_{l_n}} \qquad \text{(20)}$$

or

$$\frac{E}{W_n} y_{4n} = \int_o^{l_n} \int_o^{l_n} \frac{l_n - x}{I_{n+1}}\,dx\,dx + (l_{n+1} - l_n)\int_o^{l_n} \frac{l_n - x}{I_{n+1}}\,dx \qquad \text{(21)}$$

No constants are added to the integrals, since both $\frac{dy}{dx}$ and y vanish together with x.

These general relations, as here given, are of course in a somewhat intangible form for practical use; they will be reduced to definite formulæ for particular cases later on, but before doing so, we will prove a very important theorem, which shows that $A_{4n-2} = A_{4n-4}$, so that when A_{4n-4} has been calculated, A_{4n-4} may at once be written down as the same, thus saving 25 per cent of the preliminary work.

(To be continued.)

WATER-COOLING COAL STACKS.—Water is generally unsatisfactory in extinguishing fires in coal stacks. A case is mentioned in the *Electrical Review*, of Chicago, in which different kinds of coal were mixed, and, of necessity, stacked to a depth of 30 ft and over. The coal pile represented about 45,000 tons, and a fire broke out in the bottom centre of the stack. Several iron pipes 2 in. in diameter were sunk from top to bottom of the pile, their upper ends then being connected to fire hose. The city water supply was connected, and after 48 hours the fire was extinguished. Satisfactory results have been obtained since the fire, by driving a $1\frac{1}{2}$-in. iron rod from top to bottom of the pile at intervals of 3 ft. each way. It is found that when the rod is removed, it leaves a clear hole the full depth of the pile, and provides sufficient ventilation to keep the temperature within safe limits.

MEASUREMENT OF FREQUENCY.—A device has been developed by Schering and Engelhardt, Physikalisch-Technische Reichsanstalt for the accurate measurement of frequency. According to the *Zeitschrift für Instrumentenkunde*, of May last, a steel tuning fork 240 mm. long and 4.6 by 7.6 mm. in section, is strongly magnetised, and a coil of 1,000 turns of 0.05mm. copper wire wound on an iron core of 7.6 by 7.6 mm. section is placed between the ends of the prongs of the tuning fork. When the fork is oscillating, alternating currents are induced in the coil, and these are led to a vibration galvanometer tuned to the frequency of oscillation of the fork. If, now, a weak alternating current of a frequency to be measured is passed through the galvanometer simultaneously with the alternating current induced by the motion of the fork, the movement swings in a period corresponding to the beats produced by the superposed alternating currents, and the frequency to be determined may be calculated by the frequency of the beats. The fork can be adjusted in frequency between 40 and 60 cycles a second by adjusting a movable weight, and a displacement of 1 mm. of this weight corresponds to an alteration in frequency of 0.24 cycle a second. Measurements can be made to an accuracy of about 0.1 per cent. Another instrument was constructed that is suitable for measuring frequencies between 140 and 1,000 cycles a second. This instrument is adjusted in frequency by an electro-magnetic method.—*Electrical Review.*

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

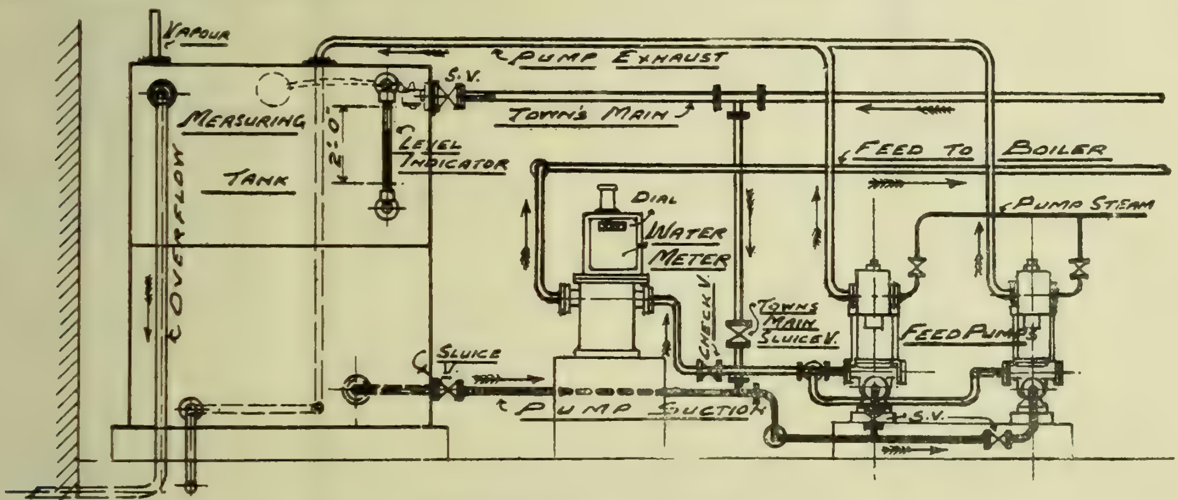
By DOUGLAS WILSON, A.M.I.Mech.E.

(Continued from Vol. VII., page 450.)

Tank and Meter Boiler Feed Layout.

A compact measuring arrangement for boiler feed is shown in diagram at Figs. 73 and 74, this being in conjunction with a steam-raising destructor plant, the trial tests of which the writer was present at. The boiler into which the destructor gases passed was a large three-flued

As soon as the water in the level indicator on the tank fell to the zero mark, an attendant immediately stopped the feed pump and opened the town's main sluice valve indicated until the water level at tank indicator reached the 2 ft. mark, when the pump was at once set to work again and the town's main valve closed. No feed was passed to boiler during this interval, and the water level in the boiler was afterwards made up, this being measured through the meter. The type of meter used was a positive measurer, consisting mainly of a cylinder and piston, in which the total displacement of the piston is



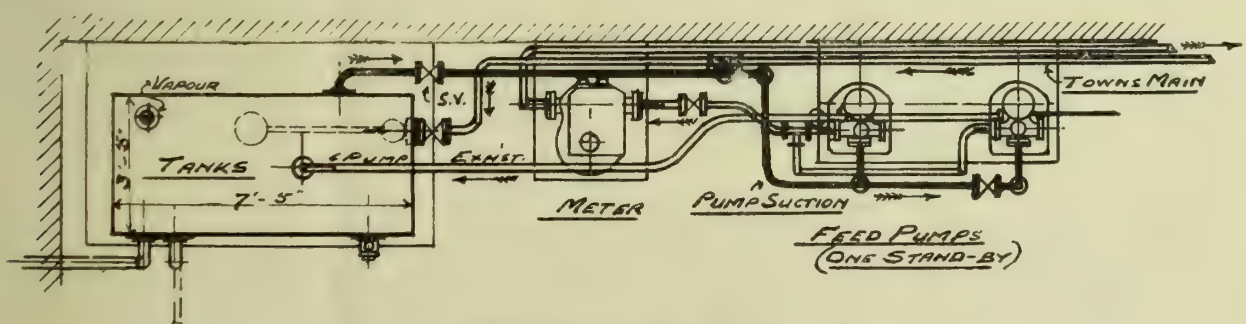
ENGINEERING LAY-OUT.—FIG. 73.

marine type, and the maker's guarantee for evaporation per hour was 10,000 lbs. of steam, when burning 40 tons of mixed shipyard refuse per day of 24 hours, at a boiler pressure of 80 lbs. per sq. in.

Referring to the diagram, it will be seen that the feed pumps are of the vertical type, one being a stand-by; and they are arranged to suck either through the measuring tanks or from the town main direct. The delivery passes then through a Kennedy water meter, and thence to boiler. The pump exhaust was taken through the

mechanically recorded on an index, the index recording the displacement of the piston only, and not the number of strokes, the makers claiming this to be an important feature.

The index dials simply record the amount of gallons passed, and do not automatically record the quantity graphically on charts, as with the Lea type of recorders. The Kennedy type of meters are suitable for hot or cold feed, if the water enters the suction of the feed pumps under pressure, the meter should preferably be on the



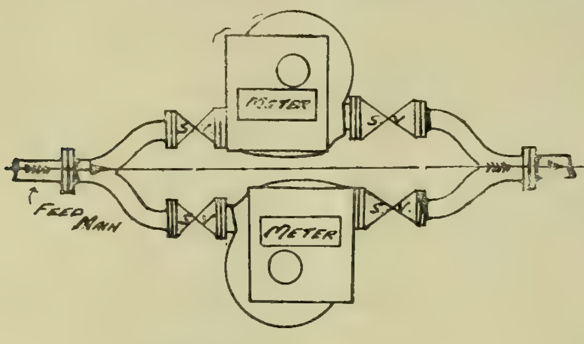
ENGINEERING LAY-OUT.—FIG. 74.

measuring tank, as shown there, by raising the feed water temperature to about 88 deg. F. With this convenient arrangement the total evaporation of the boiler was accurately found, and the calorific value of the refuse was also obtained over the test period, this latter by simply dividing the pounds of refuse burnt into the amount of water evaporated by the boiler during the time. The readings taken at the tank very favourably compared with those taken at the meter, coming within one per cent, this speaking very highly for the accuracy of the latter.

suction side, and if the level of the suction water be below the pumps, it is advisable to fix the meter on the delivery side. A check valve should be placed between the meter and the pump as close as convenient to the meter, as shown at Fig. 73. In cases where injectors are used, the meter should be placed on the suction side, as the injector steam supply would again be measured as water in passing through the meter. In cases where it is essential that there should be an unbroken record of boiler feed, the arrangement shown at Fig. 75 should be adopted, one of the meters being a stand-by.

Recorder for Steam Turbine Installation.

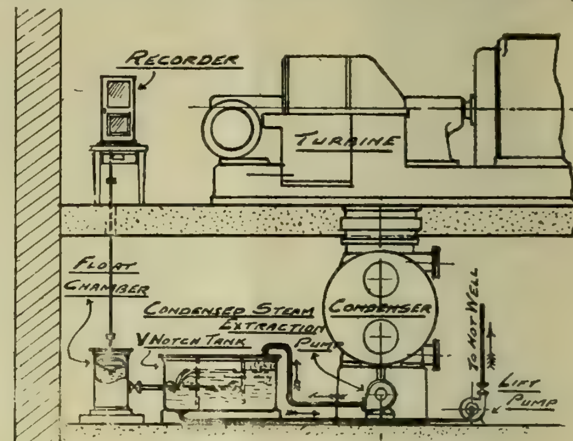
The V-shaped notch method of measuring feed condensed steam, &c., is largely adopted, and the results can be arrived at very accurately. The well-known Lea recorder is an instrument by which the variations in



Engineering Lay-out.—Fig. 75.

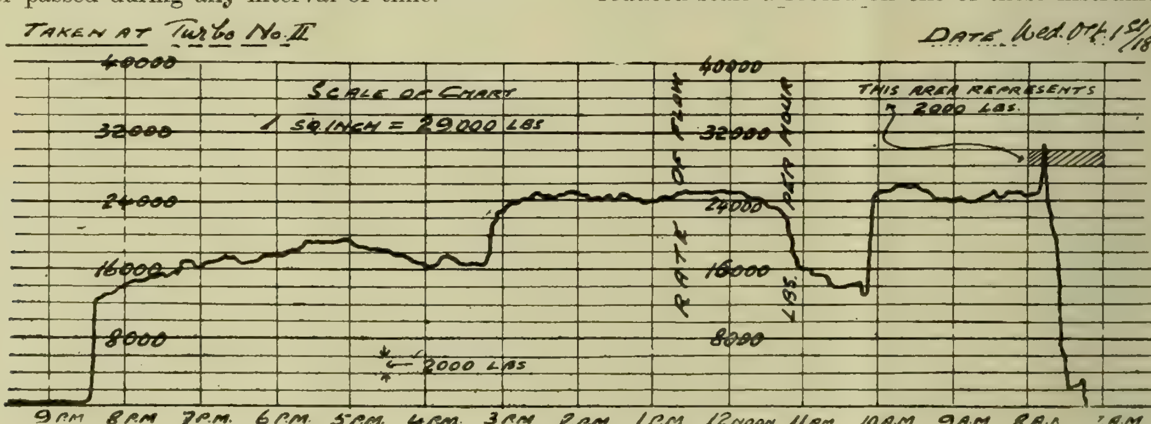
the rates of flow of water when flowing through a V or rectangular notch, can be measured and recorded graphically, the records being produced in such a way that it is a very simple matter to calculate the total weight of water passed during any interval of time.

By means of a suitable float immersed either in the tank itself or in a separate little tank connected to the middle division of the notch tank, as indicated, the rise and fall of the water in the notch can be observed at any



Engineering Lay-out.—Fig. 76.

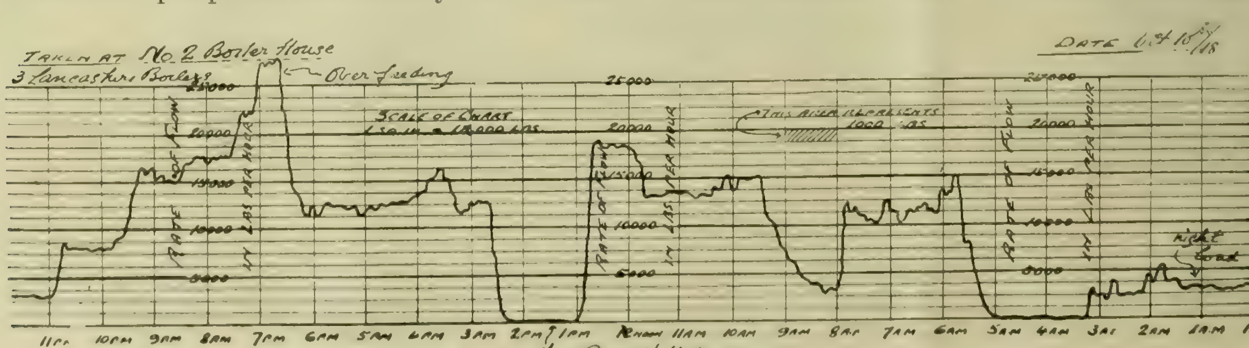
time by means of the recording instrument placed on engine room floor, as illustrated. Fig. 77 shows to a reduced scale a record off one of these instruments, the



Engineering Lay-out.—Fig. 77.

Fig. 76 shows an arrangement of this type of recorder in conjunction with a steam turbine and surface condensing plant, the condensed steam being discharged by the extraction pump indicated directly into a small

diagram shown was taken from a recorder measuring the condensed steam from a turbine, and the diagram at Fig. 78 from one measuring the feed water supplied to three Lancashire boilers. The area of the diagrams



Engineering Lay-out.—Fig. 78.

notch tank, the V-notch being fixed near the end, and over which the water falls into the end compartment or catch box. From here it is drawn off by the lift pump shown and delivered to hot well.

represent the total quantity of water passed, a square inch on each diagram representing 29,000 lbs. and 18,000 lbs. of water being passed respectively.

(To be continued.)

CHIMNEY STACKS.

By James Claughton. (Continued from Vol. VII., page 210.)

REPORT ON BOILER TEST MADE AT MESSRS. THE LABURNUM SPINNING CO. LTD., ATHERTON, MANCHESTER; CARRIED OUT BY MESSRS. E. GREEN AND A. M. HICKS.

	System of Firing. Hand.	System of Firing. "Bennis" Sprinkler Stokers and Compressed Ai Furnaces.
Date of Test	June 3—4	Sept. 30—Oct. 1.
Duration of Test	10·75 hours.	10·25 hours.
(A) Particulars of the Boilers Used :—		
Number of Boilers	3	2
Type of Boiler	Lancashire	Lancashire.
Size of Boiler	8-'0" × 30'-0"	8'-0" × 30'-0"
Heating surface of each Boiler	998 sq. feet.	998 sq. feet.
Grate surface of each Boiler	38 sq. feet.	38 sq. feet.
Ratio of heating surface to grate surface	26·26 : 1.	26·26 : 1.
Nature of draught (natural, forced, or induced)	Natural.	Natural.
Type of mechanical firing apparatus, if any	None.	"Bennis."
Heating surface of Economiser, if any	2880 sq. feet.	2880 sq. feet.
Heating surface of Superheater, if any	Not estimated.	Not estimated.
(B) Conditions of Combustion (Averages).		
Draught in inches of water gauge over fires	35 inches.	35 inches.
Draught in inches of water gauge in main flue	50 inches.	50 inches.
Draught in inches of water gauge at chimney base	85 inches.	85 inches.
Smoke produced during test	Black when firing.	None.
(C) Conditions of Evaporation (Averages).		
Temperature of feed water entering economiser	110·0 deg. Fah.	110·0 deg. Fah.
Temperature of feed water entering boiler	251·0 deg. Fah.	245·0 deg. Fah.
Steam pressure by gauge	177·5 lbs. per sq. in.	182·2 lbs. per sq. in.
Corresponding saturation temperature	378·6 deg. Fah.	380·6 deg. Fah.
Temperature of steam leaving superheater	515·3 deg. Fah.	531·0 deg. Fah.
Number of degrees of superheat	136·7 deg. Fah.	150·4 deg. Fah.
Heat supplied to each lb. of water in economiser	140·0 B.Th.U.	135·0 B.Th.U.
Heat supplied to each lb. of water in boiler	978·1 B.Th.U.	984·5 B.Th.U.
Heat supplied to each lb. of water in superheater	75·2 B.Th.U.	82·7 B.Th.U.
Heat supplied to each lb. of water—total	1193·3 B.Th U	1202·2 B Th U.
Factor of equivalent evaporation as from and at 212 deg. Fah. (boiler and economiser and superheater)	1·2306.	1·2397.
(D) Nature of Coal Used :—		
Name of coal	Shakerley Pit.	Shakerley Pit.
Class of coal	Rough Slack C'mon Slack mx'd.	Common Slack.
Calorific value of coal per lb. as fired	11,792 B.Th.U.	11,553 B.Th.U.
Approximate analysis of coal: volatile matter	33·7 per cent.	34·5 per cent.
Approximate analysis of coal: fixed carbon	54·9 per cent.	52·8 per cent.
Approximate analysis of coal: ash	11·4 per cent.	12·7 per cent.
Approximate analysis of coal: moisture	Not taken.	Not taken.
(E) Quantity of Coal Used :—		
Total weight of coal burnt	33,180 lbs.	28,448 lbs.
Coal burnt per boiler per hour	920 lbs.	1,206 lbs.
Coal burnt per sq. foot grate surface per hour	24·2 lbs.	31·7 lbs.
(F) Quantity of Water Evaporated (Actual).		
Total quantity of water evaporated	197,250 lbs.	201,750 lbs.
Water evaporated per boiler per hour	5,466 lbs.	8,558 lbs.
Water evaporated per sq. foot boiler heating surface per hour	5·47 lbs.	8·57 lbs.
Water evaporated per lb. of coal	5·94 lbs.	7.09 lbs.
Total heat supplied to water per lb. of coal	7,094 B.Th.U.	8,526 B.Th.U.
(G) Equivalent Quantity of Water Evaporated, as from and at 212 deg. Fah. :—		
Total equivalent evaporation	242,730 lbs.	250,122 lbs.
Equivalent evaporation per boiler per hour	6,726 lbs.	10,610 lbs.
Equivalent evaporation per sq. foot boiler heating surface per hour	6·73 lbs.	10·63 lbs.
Equivalent evaporation per lb. of coal	7·32 lbs.	8·79 lbs.
(H) Efficiency and Economic Result.		
Total thermal efficiency obtained	60·15 per cent.	73·80 per cent.
Summary of Results.		
Coal burnt per sq. foot grate surface per hour	24·2 lbs.	31·7 lbs.
Water evaporated as from and at 212 deg. Fah. per sq. foot boiler heating surface per hour	6·73 lbs.	10·63 lbs.
Water evaporated as from and at 212 deg. Fah. per lb. of coal	7·32 lbs.	8·70 lbs.
Total thermal efficiency obtained	60·15 per cent.	73·80 per cent.
Comparison of Results.		
Extra water evaporated as from and at 212 deg Fah. per boiler per hour		57·7 per cent.
Extra water evaporated as from and at 212 deg. Fah. per lb. of coal		20·0 per cent.
Reduction in fuel cost per 10,000 lbs. evaporated		19·3 per cent.

From the above it will be noticed that Two Boilers fitted with Mechanical Stokers were able to produce the steam that previously needed Three Boilers.

REPORT ON BOILER TEST MADE AT MESSRS. PETER SPENCE & SONS LTD., HOLLAND STREET, MANCHESTER; CARRIED OUT BY MR. E. BOYLIN AND MR A. M. HICKS.

	System of Firing. "Bennis" Coking Stoker and Compressed Air Furnace.
Date of Test	Jan. 11, 1912.
Duration of Test	8 hours.
(A) Particulars of Boilers Used :—	
Number of Boilers	1.
Type of Boiler	Lancashire.
Size of Boiler	8′-0″ × 30′-0″.
Heating Surface of each Boiler	998 sq. feet.
Grate surface of each Boiler	38 sq. feet.
Ratio of heating surface to grate surface	26·26 : 1.
Nature of draught (natural, forced, or induced)	Natural.
Type of mechanical firing apparatus, if any	"Bennis" Coker.
Heating surface of economiser, if any	960 sq. feet.
Heating surface of superheater, if any	None.
(B) Conditions of Combustion (Averages).	
Draught in inches of water gauge, over fires	·45 inches.
Draught in inches of water gauge, in side flue	·52 inches.
Draught in inches of water gauge, at chimney base	·75 inches.
Temperature of flue gases, leaving boiler	Not taken.
Temperature of flue gases, leaving economiser	400 deg. Fah.
Percentage of CO_2 in flue gases, leaving boiler	12·9 per cent.
Smoke produced during test	None.
(C) Conditions of Evaporation (Averages).	
Temperature of feed water entering economiser	52·6 deg. Fah.
Temperature of feed water entering boiler	215·0 deg. Fah.
Steam Pressure by gauge	89·9 lbs. per sq. inch.
Corresponding saturation temperature	330·8 deg. Fah.
Heat supplied to each lb. of water in economiser	163·1 B.Th.U.
Heat supplied to each lb. of water in boiler	999·0 B.Th.U.
Total	1,162·1 B.Th.U.
Factor of equivalent evaporation as from and at 212 deg. Fah. (boiler and economiser)	1·2032
(D) Nature of Coal Used :—	
Name of coal	Bridgwater.
Class of coal	Rough slack.
Calorific value of coal per lb. as fired	12,483 B.Th.U.
Approximate analysis of coal: volatile matter	35·7 per cent.
Approximate analysis of coal: fixed carbon	63·8 per cent.
Approximate analysis of coal: ash	10·5 per cent.
(E) Quantity of Coal Used :—	
Total weight of coal burnt	10,542 lbs.
Coal burnt per boiler per hour	1,318 lbs.
Coal burnt per sq. foot. grate surface per hour	34·7 lbs.
Total weight of ash and clinker	11·99 lbs.
Percentage of ash and clinker to weight of coal	11·4 per cent.
(F) Quantity of Water Evaporated (Actual).	
Total quantity of water evaporated	85,874 lbs.
Water evaporated per boiler per hour	10,734 lbs.
Water evaporated per sq. foot boiler heating surface per hour	10·76 lbs.
Water evaporated per lb. of coal	8·14 lbs.
Total heat supplied to water per lb. of coal	9,466·3 B.Th.U.
(G) Equivalent Quantity of Water Evaporated, as from and at 212 deg. Fah.	
Total equivalent evaporation	103,328 lbs.
Equivalent evaporation per boiler per hour	12,916 lbs.
Equivalent evaporation per sq. foot boiler heating surface per hour	12·94 lbs.
Equivalent evaporation per lb. of coal	9·802 lbs.
(H) Efficiency and Economic Results.	
Total thermal efficiency obtained	75·83 per cent.
Summary of Results.	
Coal burnt per sq. foot grate surface per hour	34·7 lbs.
Water evaporated as from and at 212 deg. Fah. per sq. foot boiler heating surface per hour	12·94 lbs.
Water evaporated as from and at 212 deg. Fah.	9·802 lbs.
Total thermal efficiency obtained	75·83 per cent.

(To be continued.)

POWER FACTORS.

By F. Ashton.

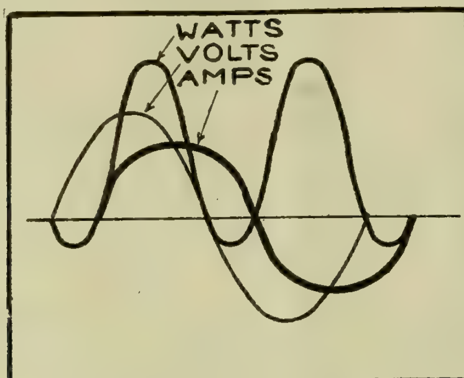
The Cause of Low-power Factors.

The disadvantages of a low-power factor are well recognised by those responsible for the working of alternating-current generating plants. At places where alternators supply current to induction motors the power factor is frequently anything but good, and the capacity of the plant is reduced in consequence. Trouble of this sort does not occur when continuous current is generated, because the pressure and current are then always in phase, but when the system is an alternating one and the load is inductive, the current lags behind the voltage and the power factor is less than unity. It will be convenient in the first place to consider that the load consists of nothing beyond a large choking coil, the power factor of which it is desired to determine. Let it be supposed that the whole of the circuit, including the choking coil itself, has a resistance of 2 ohms. Let it further be supposed that on applying a pressure of 1,000 volts to the coil a current of 3 amperes flows through it, then apparently the power absorbed in the circuit is $3 \times 1{,}000 = 3{,}000$ watts. But owing to the coil being highly inductive, the current and pressure are not by any means in phase, and a large proportion of the apparent power is returned to the generator. Since the resistance of the circuit is known to be 2 ohms and the current 3 amperes, the total watts which represent the useful work performed are found by multiplying the square of the current by the resistance, and the true watts are therefore $3^2 \times 2 = 18$. Neglecting the iron losses, it will be seen that out of the apparent 3,000 watts supplied to the circuit the useful power only amounts to 18 watts, 2,982 watts being returned to the generator. This example serves to show that the power expended in an alternating-current circuit cannot be arrived at by multiplying the volt and ammeter readings together. A wattmeter, however, will register true watts, and these watts, divided by the apparent watts, will give the power factor. In the case under consideration, it is $\frac{18}{3{,}000} = .06$. But this is an extremely low power factor, and does not in any way represent the power factor likely to be met with at a generating plant, supplying current to induction motors. The power factor, as found above, is the cosine of the angle of lag between the current and pressure, and when multiplied by the product of the volt and ammeter readings, gives the true watts expended in the circuit. Of course, if the 3 amperes mentioned above were in phase with the pressure, the useful power would be 3,000 watts and the power factor would be unity. When the load is inductive, there is necessarily a phase displacement between the pressure and current, but the lower the inductance of the circuit, the less does the phase displacement become. If it were possible, for example, to unwind the above-mentioned choking coil without disconnecting it from the supply, the current would become greater and greater and would be brought more nearly into phase with the electromotive force. If all the wire were removed, and supposing, for the sake of argument, that it was capable of carrying the heavy current which would be allowed to flow by the ohmic resistance alone (*i.e.*, 500 amperes), this current would be in phase with the pressure, for the circuit would be devoid of inductance. Although the idle or wattless currents which circulate between an inductive load and the generator do no useful work, they produce heat and therefore limit the capacity of the generator windings and mains. Owing to the current lagging behind the electromotive force, the maximum current occurs at a time when the pressure has died down to some lower value, and consequently when the poles of the alternator are in the centre of the armature coils, the current in the latter is not at its maximum value. The armature current therefore exerts a strong demagnetising effect upon the field magnets and the regulation of he alternator is impaired. The greater the phase displacement between the pressure and current, the more pronounced does this demagnetising effect become, and to maintain the machine voltage at its correct value a large increase in the exciting current may be necessary. When alternators were rated on the kilowatt basis in the same way as direct-current machines, the installation of induction motors frequently resulted in the prime mover being very much under-loaded, for the windings of the alternators were incapable of carrying the wattless currents set up by the inductive loads. The wattless currents loaded up the windings long before the prime mover was developing its maximum output. But in these days it is usual to rate alternators on the K.V.A. (kilovolt-ampere) basis, the windings having sufficient copper to deal with the wattless load so that the idle currents do not deprive the prime mover of developing its full output, although it is obvious that the smaller the wattless load, the greater is the capacity of the plant for performing useful work. An alternator required to develop 1,000 kilowatts at .8 power factor must be rated at 1,50 kilovolt amperes, for $1{,}250 \times .8 = 1{,}000$. But if the power factor were raised to unity, the capacity of the machine would become 1,250 kilowatts. It often occurs in practice that in laying out an electrical installation, considerable economy in cables, feeders, and transformers can be effected by maintaining a high-power factor.

Component Voltages and Currents.

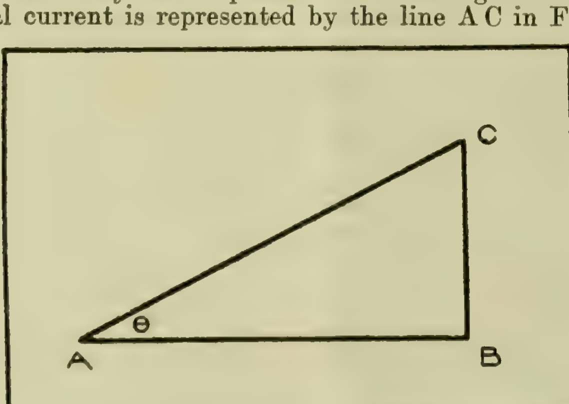
From what has been said above, it will be gathered that alternators working on inductive loads generate during one part of the alternating cycle and absorb power from the circuit at other times. This is due to the fact that when an alternating voltage is impressed upon an inductive circuit, the resultant current builds up a magnetic field, and the rapidly changing lines of force generate a back pressure. The instantaneous values of this pressure depend upon the rate of change of the magnetic lines, and consequently the back pressure attains its maximum value at the steepest part of the current curve. Obviously the steepest part of the current curve is the part where it cuts the horizontal time base (see Fig. 1), and as a result the back pressure is a quarter of a period behind the current. The back pressure is greatest when the current is reversing its sign. In an alternating-current inductive circuit the voltage may be divided into three components, which may be represented by the sides of a right-angled triangle (see Fig. 2). The voltage impressed upon the circuit is represented by the hypotenuse

A C; the voltage in phase with the current by the base A B and the inductive or back pressure by the perpendicular B C. Clearly the angle θ is the angle of phase displacement between the applied pressure and current and the cosine of this angle is the power factor. If I stands for the current flowing in the circuit and E the voltage impressed upon the circuit, then $E \times I \times \cos\theta$ gives the true or useful power



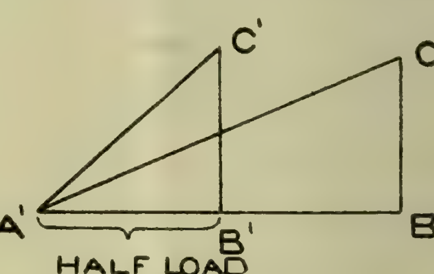
Power Factors.—Fig. 1.

expended in the circuit. The energy component A B is given by $I \times R$, where I is the current in amperes, and R the resistance in ohms, whilst the inductive component is given by $2\pi \times n \times L \times I$, where n is the periodicity, I the current as before, and L the inductance in henries. It is clear that the smaller the inductive component B C, the smaller the angle of lag between the impressed pressure and current. In other words, the smaller the inductive component the better the power factor. If there were no inductive component, the line A C would take up the same position as the line A B, and the pressure would be exactly in phase with the electromotive force. The power factor would be unity. The total current in the circuit, as registered on the ammeters, can be resolved into two components in the same way as the pressure. Assuming that the total current is represented by the line A C in Fig.



Power Factors.—Fig. 2.

2, the base A B can represent the current in phase with the pressure as before, and the perpendicular B C the idle or wattless current circulating between the alternator and load. If I represents the total current measured on the ammeters, and the power factor or cos. $\theta\,\theta$ be known, then cos. I gives the component of the current in phase with the pressure, and sine θ I the idle current. Having obtained the cosine of the angle of lag by dividing the true watts by the apparent watts, the sine of the angle can, of course, be found from tables. It will be understood that in Fig. 1 the voltage curve represents the total impressed voltage, and not the inductive voltage represented by the line B C in Fig. 2. But it is the inductive voltage that throws the pressure out of phase with the current, and the greater the inductive back pressure the greater the phase displacement. In Fig. 1 the current is lagging behind the pressure, and it will be perceived that during certain short intervals the voltage is positive whilst the current is negative, and at these times the watts are also negative, as shown by the small loops in the watt curve below the horizontal time base. The watt curve is obtained by multiplying together the ordinates of the pressure and current curves at various points. When the watts are negative the alternator receives power from the external circuit. If the load is composed entirely of incandescent lamps, it is for all intents and purposes purely non-inductive, and the power factor is unity, but when induction motors are connected to the circuit the displacement between the current and pressure is appreciable. Transformers also tend to lower the power factor, but not to anything like the same extent as induction motors. These motors, it is to be remembered, necessarily have an air gap, which necessitates an appreciable magnetising cur-



Power Factors.—Fig. 3.

rent, and it is this current that lowers the power factor. At all loads the magnetising current of an induction motor is practically constant, so that the lower the mechanical load the lower the power factor. This will readily be understood from Fig 3, where the full load conditions are represented by the triangle A^1 B C, the line A^1 C representing the total current put into the motor, the line B C the magnetising current, and the line A^1 B the useful working current. When the load on the motor is reduced to half its normal value, however, the useful current input is also halved, as shown by the line $A^1 B^1$, whilst the magnetising current $B^1 C^1$ remains practically constant, as before, the effect being to increase the angle B A^1 C to $B^1 A^1 C^1$, and the power factor is consequently lowered. When, therefore, a large number of induction motors are worked underloaded a low power factor is to be expected. Large motors, such as those installed in rolling mills, are liable to have a bad effect upon the power factor, on account of their relatively large air gap, but a large number of small motors will also produce the same effect, especially if they work under-loaded. It is seldom that the power factor of an ordinary industrial plant exceeds .85, and frequently it is as low as .6.

(To be continued.)

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 37½ lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 1 11·0	6 2 22·0	10 0 5·0	13 1 16·0	16 2 27·0	1 0 0 10·0	1 3 1 21·0	1 6 3 4·0	1 10 0 15·0	0
1	0 1 9·5	3 2 20·5	7 0 3·5	10 1 14·5	13 2 25·5	17 0 8·5	1 0 1 19·5	1 3 3 2·5	1 7 0 13·5	1 10 1 24·5	1
2	0 2 19·0	4 0 2·0	7 1 13·0	10 2 24·0	14 0 7·0	17 1 18·0	1 0 3 1·0	1 4 0 12·0	1 7 1 23·0	1 10 3 6·0	2
3	1 0 0·5	4 1 11·5	7 2 22·5	11 0 5·5	14 1 16·5	17 2 27·5	1 1 0 10·5	1 4 1 21·5	1 7 3 4·5	1 11 0 15·5	3
4	1 1 10·0	4 2 21·0	8 0 4·0	11 1 15·0	14 2 26·0	18 0 9·0	1 1 1 20·0	1 4 3 3·0	1 8 0 14·0	1 11 1 25·0	4
5	1 2 19·5	5 0 2·5	8 1 13·5	11 2 24·5	15 0 7·5	18 1 18·5	1 1 3 1·5	1 5 0 12·5	1 8 1 23·5	1 11 3 6·5	5
6	2 0 1·0	5 1 12·0	8 2 23·0	12 0 6·0	15 1 17·0	18 3 0·0	1 2 0 11·0	1 5 1 22·0	1 8 3 5·0	1 12 0 16·0	6
7	2 1 10·5	5 2 21·5	9 0 4·5	12 1 15·5	15 2 26·5	19 0 9·5	1 2 1 20·5	1 5 3 3·5	1 9 0 14·5	1 12 1 25·5	7
8	2 2 20·0	6 0 3·0	9 1 14·0	12 2 25·0	16 0 8·0	19 1 19·0	1 2 3 2·0	1 6 0 13·0	1 9 1 24·0	1 12 3 7·0	8
9	3 0 1·5	6 1 12·5	9 2 23·5	13 0 6·5	16 1 17·5	19 3 0·5	1 3 0 11·5	1 6 1 22·5	1 9 3 5·5	1 13 0 16·5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 3·125	0 6·25	0 9·375	0 12·5	0 15·625	0 18·75	0 21·875	0 25·0	1 0·125	1 3·25	1 6·375	1 9·5	

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 37½ lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 13 1 26	3 6 3 24	5 0 1 22	6 13 3 20	8 7 1 18	10 0 3 16	11 14 1 14	13 7 3 12	15 1 1 10	0
10	0 3 1 11	1 16 3 19	3 10 1 7	5 3 3 5	6 17 1 3	8 10 3 1	10 4 0 27	11 17 2 25	13 11 0 23	15 4 2 21	10
20	0 6 2 22	2 0 0 20	3 13 2 18	5 7 0 16	7 0 2 14	8 14 0 12	10 7 2 10	12 1 0 8	13 14 2 6	15 8 0 4	20
30	0 10 0 5	2 3 2 3	3 17 0 1	5 10 1 27	7 3 3 25	8 17 1 23	10 10 3 21	12 4 1 19	13 17 3 17	15 11 1 15	30
40	0 13 1 16	2 6 3 14	4 0 1 12	5 13 3 10	7 7 1 8	9 0 3 6	10 14 1 4	12 7 3 2	14 1 1 0	15 14 2 26	40
50	0 16 2 27	2 10 0 25	4 3 2 23	5 17 0 21	7 10 2 19	9 4 0 17	10 17 2 15	12 11 0 13	14 4 2 11	15 18 0 9	50
60	1 0 0 10	2 13 2 8	4 7 0 6	6 0 2 4	7 14 0 2	9 7 2 0	11 0 3 26	12 14 1 24	14 7 3 22	16 1 1 20	60
70	1 3 1 21	2 16 3 19	4 10 1 17	6 3 3 15	7 17 1 13	9 10 3 11	11 4 1 9	12 17 3 7	14 11 1 5	16 4 3 3	70
80	1 6 3 4	3 0 1 2	4 13 3 0	6 7 0 26	8 0 2 24	9 14 0 22	11 7 2 20	13 1 0 18	14 14 2 16	16 8 0 14	80
90	1 10 0 15	3 3 2 13	4 17 0 11	6 10 2 9	8 4 0 7	9 17 2 5	11 11 0 3	13 4 2 1	14 17 3 27	16 11 1 25	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	16 14 3 8	33 9 2 16	50 4 1 24	66 19 1 4	83 14 0 12	100 8 3 20	117 3 3 0	133 18 2 8	150 13 1 16	167 8 0 24	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 38 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 1 16	6 3 4	10 0 20	13 2 8	0 16 3 24	1 0 1 12	1 3 3 0	1 7 0 16	1 10 2 4	0
1	0 1 10	3 2 .6	7 0 14	10 2 2	13 3 18	0 17 1 6	1 0 2 22	1 4 0 10	1 7 1 26	1 10 3 14	1
2	0 2 20	4 0 8	7 1 24	10 3 12	14 1 0	0 17 2 16	1 1 0 4	1 4 1 20	1 7 3 8	1 11 0 24	2
3	1 0 2	4 1 18	7 3 6	11 0 22	14 2 10	0 17 3 26	1 1 1 14	1 4 3 2	1 8 0 18	1 11 2 6	3
4	1 1 12	4 3 0	8 0 16	11 2 4	14 3 20	0 18 1 8	1 1 2 24	1 5 0 12	1 8 2 0	1 11 3 16	4
5	1 2 22	5 0 10	8 1 26	11 3 14	15 1 2	0 18 2 18	1 2 0 6	1 5 1 22	1 8 3 10	1 12 0 26	5
6	2 0 4	5 1 20	8 3 8	12 0 24	15 2 12	0 19 0 0	1 2 1 16	1 5 3 4	1 9 0 20	1 12 2 8	6
7	2 1 14	5 3 2	9 0 18	12 2 6	15 3 22	0 19 1 10	1 2 2 26	1 6 0 14	1 9 2 2	1 12 3 18	7
8	2 2 24	6 0 12	9 2 0	12 3 16	16 1 4	0 19 2 20	1 3 0 8	1 6 1 24	1 9 3 12	1 13 1 0	8
9	3 0 6	6 1 22	9 3 10	13 0 26	16 2 14	1 0 0 2	1 3 1 18	1 6 3 6	1 10 0 22	1 13 2 10	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Weight.
	3·16	6·33	9·50	12·66	15·83	19·0	22·16	25·33	28·5	31·67	34·83	38	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 38 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 13 3 20	3 7 3 12	5 1 3 4	6 15 2 24	8 9 2 16	10 3 2 8	11 17 2 0	13 11 1 20	15 5 1 12	0
10	0 3 1 16	1 17 1 8	3 11 1 0	5 5 0 20	6 19 0 12	8 13 0 4	10 6 3 24	12 0 3 16	13 14 3 8	15 8 3 0	10
20	0 6 3 4	2 0 2 4	3 14 2 16	5 8 2 8	7 2 2 0	8 16 1 20	10 10 1 12	12 4 1 4	13 18 0 24	15 12 0 16	20
30	0 10 0 20	2 4 0 12	3 18 0 4	5 11 3 24	7 5 3 16	8 19 3 8	10 13 3 0	12 7 2 20	14 1 2 12	15 15 2 24	30
40	0 13 2 8	2 7 2 0	4 1 1 20	5 15 1 12	7 9 1 4	9 3 0 24	10 17 0 16	12 11 0 8	14 5 0 0	15 18 3 20	40
50	0 16 3 24	2 10 3 16	4 4 3 8	5 18 3 0	7 12 2 20	9 6 2 12	11 0 2 4	12 14 1 24	14 8 1 16	16 2 1 8	50
60	1 0 1 12	2 14 1 4	4 8 0 24	6 2 0 16	7 16 0 8	9 10 0 0	11 3 3 20	12 17 3 12	14 11 3 4	16 5 2 24	60
70	1 3 3 0	2 17 2 20	4 11 2 12	6 5 2 4	7 19 1 24	9 13 1 16	11 7 1 8	13 1 1 0	14 15 0 20	16 9 0 12	70
80	1 7 0 16	3 1 0 8	4 15 0 0	6 8 3 20	8 2 3 12	9 16 3 4	11 10 2 24	13 4 2 16	14 18 2 8	16 12 2 0	80
90	1 10 2 4	3 4 1 24	4 18 1 16	6 12 1 8	8 6 1 0	10 0 0 20	11 14 0 12	13 8 0 4	15 1 3 24	16 15 3 16	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	16 19 1 4	33 18 2 8	50 17 3 12	67 17 0 16	84 16 1 20	101 15 2 24	118 15 0 0	135 14 1 4	152 13 2 8	169 12 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

RECONSTRUCTION AND INDUSTRY.

By W. R Needham.

(*Concluded from Vol. VII., page 451.*)

Industrial Councils.

The Industrial Council, representative of all interests, must become an institution. In order to hasten the good time which we anticipate with high hopes, certain suggestions seem relevant, among them:—

1. The employer should pay special attention to hygienic conditions, and keep in mind the fact that the psychological factor is an extremely important one. Interesting work during a reasonable number of hours in light, airy, clean workshops will, all things else being tolerably equal, produce excellent results, both as regards actual output and its quality. If employers prove recalcitrant, legislation should render all such negligence illegal.

2. On their part, the workers should agree to a voluntary withdrawal—under effective guarantees of good faith and fair dealing—of the trade union restriction on output originally introduced as a protection against exploitation of their skill and worth. This can only be accomplished with any real hope of success when—

3. Each class learns so to trust the other as to treat with and assist the other. The public school spirit can be carried into commerce. Council and arbitrament must supersede strife, whether in international or national or local affairs. Capital and Labour should realise their aims as complementary, not antagonistic. It is no tug-of-war; they should pull together between the same shafts. Labour provides the machinery, capital the power. They are mutually dependent, and are efficient and operative in harness. When both share the burden and reap the harvest, they will be a League of Service instead of a Balance of Power. The League of Service rests on a sure footing, the Balance of Power is at best a grotesquely top-heavy pyramid wobbling on its apex.

4. The Imperial Parliament must provide for impartial adjudication of outstanding differences. The Board must be in frequent and regular session, must be representative, command respect, and inspire the confidence of all parties.

5. In regard to works management and organisation, much can be done to stimulate the workers' interest in their progress. Some progressive firms display periodical output charts or diagrams in order to encourage a healthy rivalry of effort between the various departments. Where the object is to appraise the foremost, not penalise the others, the result should be gratifying. Here all depends upon the spirit of the management. But at the worst, the data is departmental, not individual.

6. In fixing rates of pay special attention should be directed towards new departures. A representative advisory board might consider such delicate cases, and where the rate can only be tentatively determined, this fact should be made known to the operatives concerned. Any subsequent revision should be made with intent to fashion a juster scale, not to exploit keen and rapid workers. Thus the new scale should as often be at a higher as at a lower rate of payment. Quality of workmanship, no less than speed of production, ought to be a leading factor in the expression obtained. Anything shoddy reveals really dishonest work. Put men on their honour, and be on your honour yourself. Let men see that a good thing is expected from them, and when obtained that it is appreciated; and in the result a higher morality, a great trustworthiness, will be discovered.

7. The war-time expedient of restricting excessive return on capital could with advantage be carried over into the peace programme. A graduated scale would, of course, be absolutely necessary, as a strictly uniform rate would prove manifestly unjust in many instances. First-class, securely established businesses, where capital and interest are practically assured, would grade lower than those where the risks are greater. A large proportion of the excess profits, however, should find suitable outlet in providing for legitimate extensions and securing improved working conditions for operatives.

I have left over the discussion of such specific questions as those of standardisation and stock till some later occasion.

Unity of Purpose.

If the last few years of world travail have done nothing else than teach us the criminal folly and crass futility of all resort to mere brute force, it has not been unrelieved tragedy. Millions of aching hearts, millions of empty chairs—these follow in the wake of over-weening, unscrupulous ambition, the lust to power, the distrust of all the nobler instincts of life. This nightmare horror, or the necessity for it, has been disproved over and over again. The mother-love of every normal woman disproves it.

As with nations, so with groups within a nation. The League of Nations—Heaven grant it become a fact as well as an idea!—must find its counterpart in the community of classes, if life is to be worth while. When fighting a common foe we can sink our differences. Conservative and Labour leader can use a common platform. Shall Peace find us united? It would seem not.

Yet, to reconstruct the world of us on sane and friendly lines is an enterprise worth all of inspiration and high endeavour we can muster. The thing should be no impossible task. We need union, not faction. We had it when destruction from without was in the air. Let us strive for it no less now that construction has to be attempted. It is doubly necessary in that disruptive forces assail us from within. We do not desire, cannot desire, to reproduce here the seething chaos so rampant on the Continent. It is ours to build if we will, to build wisely, if we put our mind to the task. The good of all is the good of each; the weal of each should swell the well-being of all. These things are not merely visionary; they are as practical as they are vitally necessary. Really, any other course is foredoomed to failure.

Let us be wise, and continue humane.

(*Concluded.*)

THE EFFECTS OF AGE ON STEAM BOILERS.

By Edward Ingham, A.M.I.Mech.E.

The question, "Does a boiler deteriorate with age?" is one which perhaps to the majority of steam users would appear to require no answer. It seems in the very nature of things for deterioration and gradual decay to take place as time goes on, and in the case of a steam boiler, the plates of which are exposed repeatedly to the hot gases from the furnace, and to the action of the feed water, one might reasonably expect that more or less rapid deterioration was inevitable.

It is well, however, to look into this question a little more carefully. If we ask ourselves "why are boilers condemned and thrown upon the scrap heap?" we reply that it is generally because the plates have become wasted by corrosion, or because they have become fractured beyond repair, so that the boiler is no longer able to withstand safely the pressure of steam to which it is exposed. That either corrosion or serious fracture is the usual cause of "death" in the case of a boiler will, we think, be admitted by all.

This being the case, we are led to inquire as to what are the causes of corrosion and fracture. If these causes are preventable, then there is no reason why a boiler should not continue to work for an indefinite period.

Corrosion occurs both internally and externally. The internal form is due to the presence of impurities in the feed water. If, for example, the water contains acids, these will attack the plates and gradually eat away the metal. Generally speaking, it may be said that internal corrosion is due to the acid action of the feed water.

External corrosion is almost invariably the result of allowing the plates to become damp externally.

Obviously, internal corrosion will not occur if the feed water be free from objectionable ingredients. Even if there be corrosive acids present, these may in most cases be neutralised by the addition of suitable re-agents to the water.

The prevention of external corrosion is a comparatively simple matter, all that is really necessary being to maintain the external surfaces of the plates in a dry condition. Thus, the boiler should be set in a dry situation, the foundations well drained, and any leakage prevented as soon as it presents itself.

Fractures in boiler plates may be brought about in a number of ways. The plates may be made of unsound material, or they may have been improperly treated during manufacture, so that initial fractures are liable to be set up and extend under working conditions. These are clearly preventable causes, particularly nowadays, when steel of the highest quality can be obtained, and when boiler making machinery is of such high class construction.

The atomic forces of expansion and contraction set up by sudden heating and cooling of the plates are occasionally responsible for fractures. It is seldom realised by the average boiler attendant that these forces are practically irresistible. It can be shown by calculation that the stresses set up by pouring cold water over a hot mild steel plate may be as much as the ultimate strength of the metal. This being the case, the folly of playing over the plates with a hose pipe immediately after a boiler has been blown off, with the object of cooling down the boiler quickly, will be at once apparent.

Serious stresses may also be set up, tending to cause more or less important fractures, by raising steam very rapidly from cold water. It is always advisable to allow as much time as possible in which to raise steam, and in the case of a large Lancashire boiler, at least 4 hours should be allowed for the purpose. The practice of leaving the fire doors open for long periods, so allowing cold air to rush through the furnace in large volumes, is clearly one which will cause chilling of the hot plates, and may in severe cases lead to fracture. Similarly, the introduction of cold feed water in a solid jet in close proximity to the plates may have the same effect.

Overheating is another trouble which may be responsible for fracture. It may result from the presence of scale on the plates, grease in the feed water, or shortness of water. The use of a pure feed water, or the satisfactory treatment of the water, will do away with scale and grease, whilst reasonable care on the part of the fireman will prevent shortness of water.

We have now enumerated all the principal causes of corrosion and fracture, viz., the causes principally responsible for deterioration of steam boilers. On reviewing these, it will be seen that each one of them is preventable. It follows therefore that there is no good reason why deterioration of a steam boiler should take place. There can indeed be no question that if the conditions of working be suitable, a boiler may be worked for very long periods without becoming in any way the worse for wear. These conditions may be summarised as follow:—

(1) The boiler should be well designed and constructed of only the very best materials, by high class firms.

(2) It should be well set in a dry situation, large surfaces of brick work in contact with the plates being particularly avoided.

(3) The feed water should be pure, or if pure water is not obtainable, the water should be treated with suitable reagents so as to neutralise any acid tendency, and prevent the formation of hard scale.

(4) The boiler should be placed under the care of a thoroughly trained and careful fireman.

(5) It should be periodically inspected and reported on by independent experts, such as the inspectors of recognised boiler insurance companies, so that any defect may be discovered in its early stages, and made good before it becomes of importance.

The arguments put forward in the foregoing are, we think, fairly convincing, but facts always carry more weight than arguments. For this reason, we may add that there are any number of cases which could be cited to show that boilers have frequently been worked for many years, often 20 or even 30, without showing any evidence of deterioration, and we know of numerous instances where whole ranges of boilers, after having worked 20 years or more, have been taken out and sold, put down for a fresh term of service, and accepted for insurance at the same pressure as that for which they were originally

constructed. A few years ago, a range of six boilers, constructed originally for a pressure of 90 lbs. per square inch, was taken out after nearly 20 years service, and substituted by new boilers to work at a higher pressure. The old boilers were sold to a firm who proposed them for insurance at 100lbs. pressure, and they were accepted at this pressure by a leading boiler insurance company. These boilers were of good design and construction by a leading maker, and had been fed with good water and well tended throughout, with the result that age had had no effect in causing deterioration.

It seems reasonable therefore to conclude that age is a factor of little or no importance in bringing about deterioration of steam boilers: it is the conditions under which they are worked, and not the number of years they have been in service, which determines the working life of these vessels.

WAR ADVANCES AND WAR BONUSES.

The Ministry of Labour makes the following announcement:—

Deputation to the Minister of Labour from the Federation of Engineering and Shipbuilding Trades, Amalgamated Society of Engineers, and the National Federation of General Workers.

A deputation consisting of representatives of the Federation of Engineering and Shipbuilding Trades, Amalgamated Society of Engineers, and the National Federation of General Workers, was received by Sir Robert Horne, the Minister of Labour, at Montagu House, Whitehall, on the 19th September, 1919. The Minister was accompanied by Mr. G. J. Wardle, Sir David Shackleton, Mr. H. J. Wilson, and other officials of the Ministry of Labour. They discussed with Sir Robert Horne the following points:—

(1) The consolidation of war advances and war bonuses into permanent rates of wages.

(2) The procedure to be adopted in connection with the next application for a general advance of wages.

(3) The continuance of the Wages (Temporary Regulation) Act.

The case for the deputation was stated by Mr. John Hill, Mr. J. Brownlie, Mr. E. Bevin, and Mr. J. Jones, M.P. The Minister of Labour, in his reply, first dealt with the question raised by the deputation as to the legal powers of the Interim Court of Arbitration to deal with the consolidation of war advances into base rates of wages, and explained this matter in its relation to the special circumstances of the Wages (Temporary Regulation) Act, and pointed out that the question of the readjustment of base rates of wages by means of the incorporation of war advances and war bonuses was one which could most properly and most suitably be discussed and settled by the employers and workpeople in the various trades. In dealing with the second question, the Minister said that he had hoped that advantage would have been taken by the persons concerned of the period during which the Act was in force to discuss and settle the method by which wages questions would be dealt with in the several trades. At the time of the armistice, when the Wages (Temporary Regulation) Act was passed, it had been made clear that the Act was a temporary measure, intended only to meet the circumstances immediately following the cessation of hostilities. In May, when the original period of six months had come to an end, it was found necessary to extend the Act for a further six months. He gathered from the remarks of the speakers that adequate progress had not been made with the consideration of the wages position, especially as regards the engineering and shipbuilding trades. He quoted, however, other trades where it had been, or was being, done, and he suggested that negotiations should be opened up with employers without delay. In regard to the continuance of the Wages (Temporary Regulation) Act, which in the ordinary course would expire on November 21st, 1919, at present he would express no definite views, but would wish to be advised by organisations of employers and employees. He anticipated that on the whole they did not want the Act continued. He thought, however, that it was desirable that there should be some form of arbitration tribunal to which disputing parties could refer industrial matters when they desired to do so.

It was arranged that the Ministry of Labour should send a letter to organisations of employers and employees drawing their attention to the fact that the Wages (Temporary Regulation) Act will normally come to an end in November and to the desirability of discussing the wages situation (including the question of placing wages on a permanent basis) as soon as possible so that the trades might arrive at an understanding as to the way in which wages questions were to be settled in future. The Minister requested the deputation to consider with the members of the respective trade unions the question of the continuance of the Act, and to inform them of their views at a further meeting. In the meantime the Minister will endeavour to ascertain the views of employers also on this question.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(*Continued from Vol. VII., page 433.*)

The distance N in the development is equal to the distance N in Fig. 58. Table 12 gives dimensions of several sizes of single-slotted Rider gears. Fig. 63 shows the main valve, and Fig. 64 the expansion valve for a multiple-slotted valve gear. In multiple-slotted valves, at the earliest cut-off position, there is a danger of the slot E in the expansion valve uncovering the slot F in the main valve, and causing a re-opening to steam before the main valve has cut off; but if the distance D (length of bar of expansion valve, measured horizontally) is made positive lap at earliest cut-off position + width slot in main valve, measured horizontally + OV (Fig. 62) + ¼ in., the danger will be obviated. The point V in Fig. 62 is at the intersection of the radial at the main cut-off with the relative travel circle OR.

Corliss Gears.

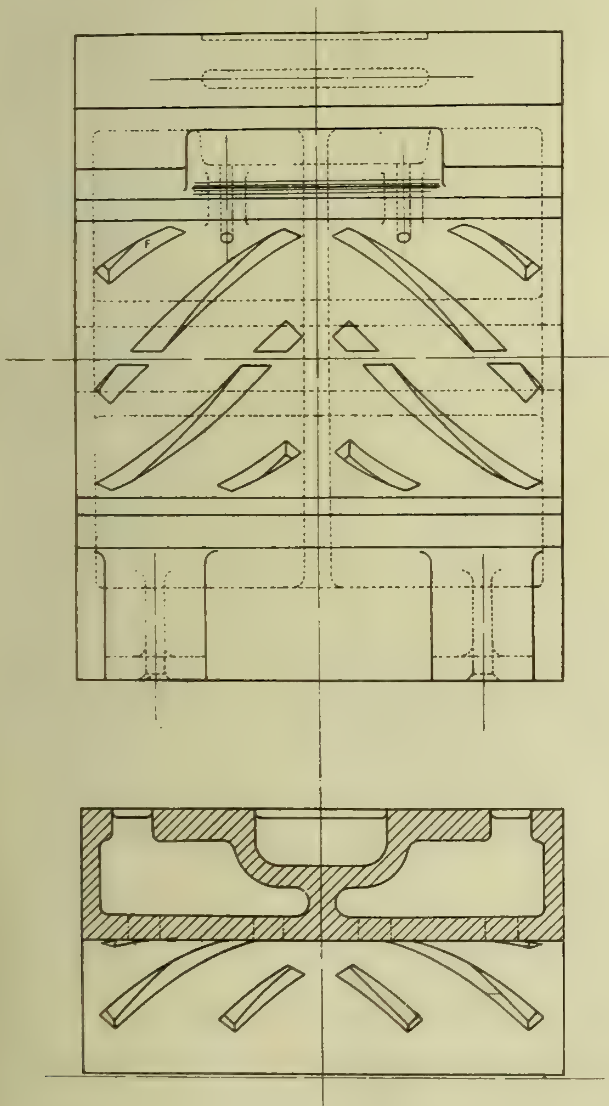
The valve gears previously discussed, although possessing generally the merit of simplicity, have

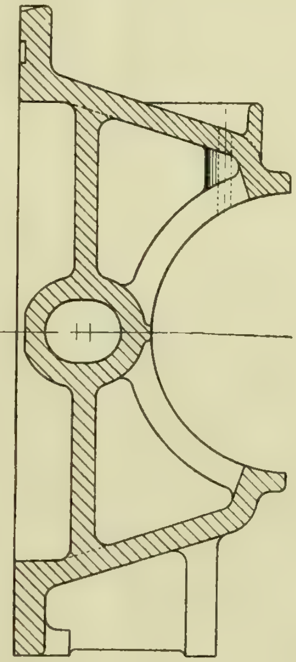
certain disadvantages. A considerable amount of power is required to drive the flat, unbalanced slide valve, and whilst this difficulty has been overcome in the case of the piston valve, the clearance volume in the latter type is greater.

Again, where the same valve edges serve for steam admission and exhaust, the initial steam is condensed by contact with the cold exhaust passages. The Corliss valve gear was designed for the purpose of eliminating the above disadvantages .

The design embodies separate valves for admission for the same cylinder, shows the valve levers and trip gear in position. The steam eccentric rod is connected to the carrier rail E at F, and imparts a reciprocating movement to same. The carrier rail carries two cast-iron trip boxes G, containing the trip catches H and trip cams J. The valve levers K are keyed on the valve spindles, the top end of the lever is attached to the dashpot rod and the bottom end to the die rods L.

Considering the front steam valve (the left-hand one in Fig. 66), we see that, when the eccentric rod





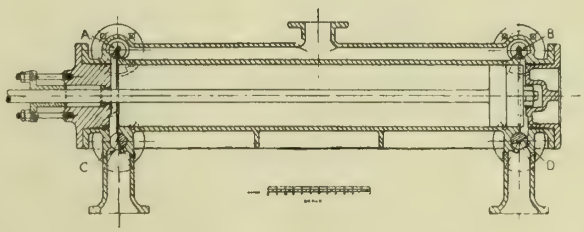


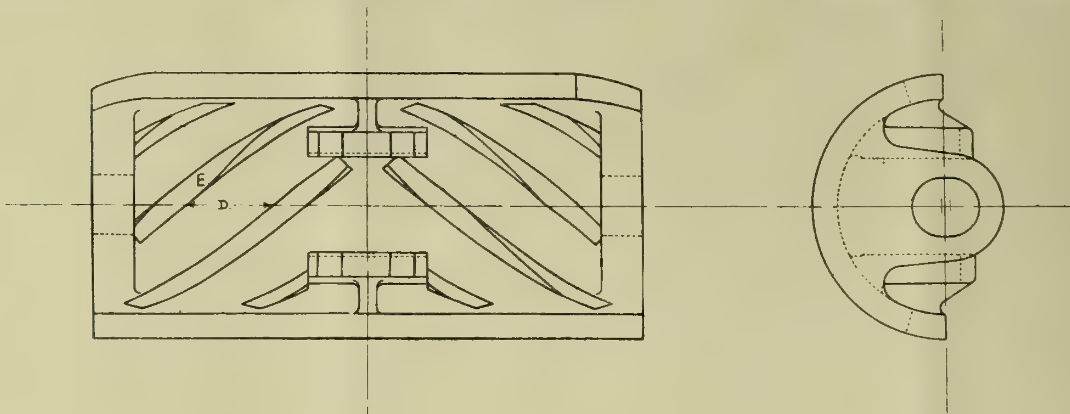
Fig. 63. Governors. Fig. 65.

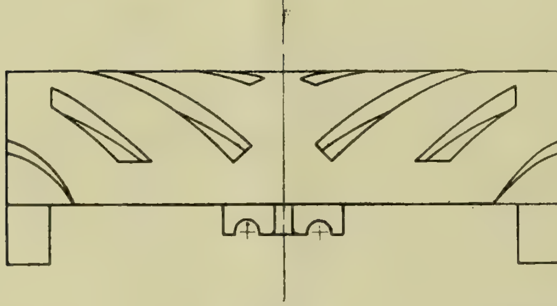
and exhaust, and governing is provided for by some form of trip motion. In the more modern engines, separate steam and exhaust eccentrics are employed in order to ensure that the governor may act over a wide range of cut-off.

Referring to Fig. 65, which is a longitudinal section of a Corliss cylinder with valves in position—A is the front steam valve; B the back steam valve; C, the front exhaust valve; and D the exhaust valve for the back end.

Fig. 66, which is an elevation of the valve gear moves the carrier rail to the right, and with it the trip box, the fulcrum of the trip lever M will have moved an equal distance to the right. the top end of the trip lever being held in position by the governor through the medium of rod P and links N; the lever takes up the position shown by the dotted lines, thus lifting the right-hand edge of the cam J. which in turn lifts the die rod L from contact with the catch H. As soon as the die rod is released, the pull of the dashpot spring at top arm of lever K swings the latter over, and so closes the valve. Two

projections Q are provided on the die rod, so that if the dashpot springs fail to close the valve, either in one direction, and the end of the trip lever is in the extreme position in the other direction, should





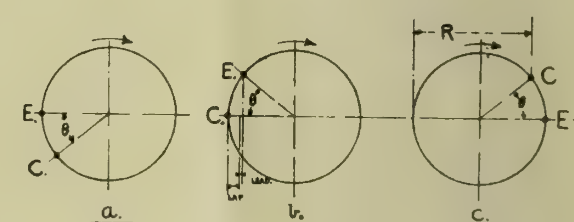
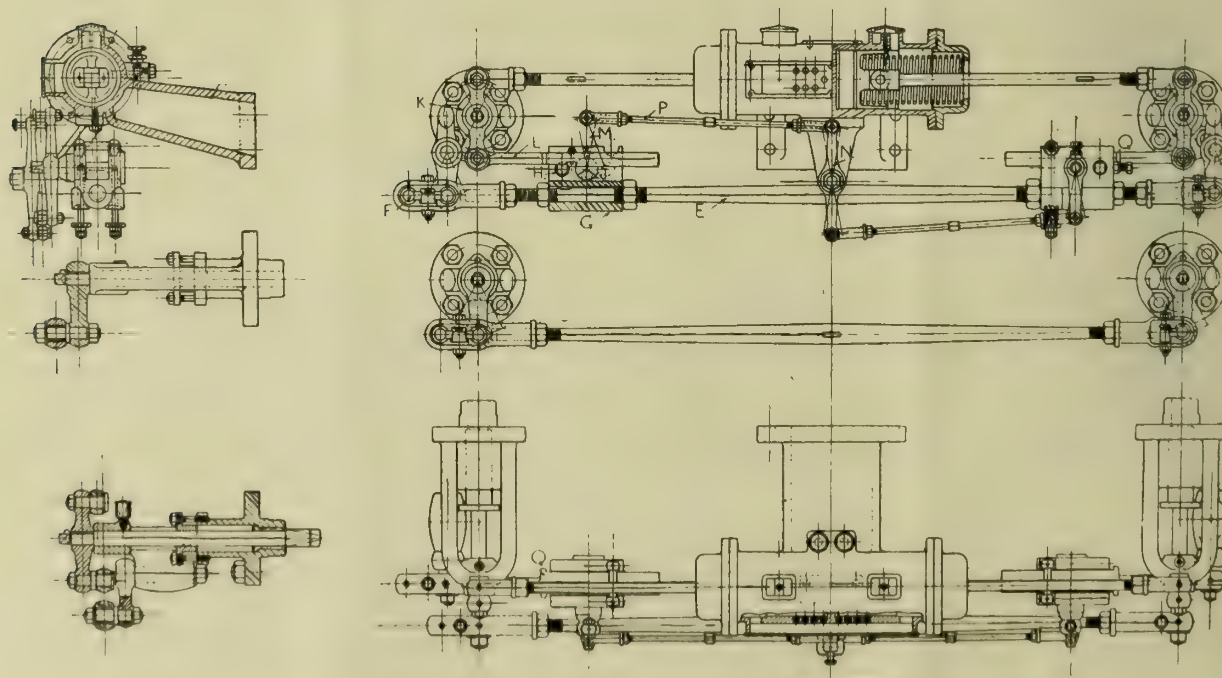


Fig. 64. Governors. Fig. 67.



Governors.—Fig. 66.

through failure of the spring or seizure of the valve, the trip box will close it on the return stroke.

The angles formed by the trip levers when the carrier rail is at the extreme limit of its movement be so arranged that any doubling up or locking shall not take place. The eccentric leads the crank by an angle of 40 deg.

Three positions of crank and eccentric are given

TABLE 12.

Travels.		Main Valve.				Expansion Valve.					Guide for Valve Spindle.		Diameter of Ecc. Rod.		Eccentric Sheave.		Controlling Force of Governor Measured at Surface of Expansion Valve.		
Main Valve.	Expansion Valve.	Depth of Port G.	Width of Port g.	Steam Lap.	Maximum Positive Lap.	Maximum Negative Lap.	Total Circular Movement of Valve.	Radius of Valve.	Metal Thickness.	Diameter of Valve Spindle.	Diameter.	Length.	Maximum.	Minimum.	Diameter.	Width.	Total.	Per Sq. Inch.	R.P.M. of Governor.
In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	Lbs.	Lbs.	
$2\frac{15}{16}$	$2\frac{15}{16}$	$5\frac{1}{2}$	$\frac{3}{4}$	$\frac{21}{32}$	$\frac{11}{32}$	$\frac{17}{32}$	$\frac{7}{8}$	$1\frac{13}{16}$	$\frac{3}{8}$	$1\frac{1}{8}$	$2\frac{1}{4}$	$5\frac{1}{4}$	$1\frac{3}{8}$	1	$8\frac{1}{4}$	$1\frac{7}{8}$	10·9	·322	325
$3\frac{3}{4}$	$3\frac{3}{4}$	$6\frac{7}{8}$	1	$\frac{27}{32}$	$\frac{7}{16}$	$\frac{11}{16}$	$1\frac{1}{8}$	$2\frac{5}{16}$	$\frac{1}{2}$	$1\frac{1}{4}$	$2\frac{3}{8}$	6	$1\frac{1}{2}$	$1\frac{1}{8}$	$9\frac{3}{4}$	$2\frac{1}{8}$	16·2	·3	300
$4\frac{1}{4}$	$4\frac{1}{4}$	$8\frac{3}{8}$	$1\frac{1}{8}$	$\frac{31}{32}$	$\frac{1}{2}$	$\frac{2}{3}$	$1\frac{9}{32}$	$2\frac{13}{16}$	$\frac{1}{2}$	$1\frac{3}{8}$	$2\frac{5}{8}$	7	$1\frac{5}{8}$	$1\frac{3}{8}$	$11\frac{1}{4}$	$2\frac{3}{8}$	13·4	·18	300
$5\frac{7}{8}$	$5\frac{7}{8}$	$10\frac{1}{8}$	$1\frac{5}{8}$	$1\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{16}$	$1\frac{3}{4}$	$3\frac{5}{16}$	$\frac{1}{2}$	$1\frac{3}{8}$	$2\frac{7}{8}$	$7\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$13\frac{1}{4}$	$2\frac{3}{4}$	20	·17	275
$6\frac{3}{8}$	$6\frac{3}{8}$	$11\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{16}$	$\frac{3}{4}$	$1\frac{5}{32}$	$1\frac{29}{32}$	$3\frac{11}{16}$	$\frac{5}{8}$	$1\frac{1}{2}$	$3\frac{1}{8}$	$8\frac{7}{8}$	2	$1\frac{5}{8}$	$14\frac{3}{4}$	$3\frac{1}{4}$	24	·168	250
7	7	13	$1\frac{7}{8}$	$1\frac{9}{16}$	$\frac{13}{16}$	$1\frac{1}{4}$	$2\frac{1}{16}$	$4\frac{3}{16}$	$\frac{5}{8}$	$1\frac{5}{8}$	$3\frac{3}{8}$	$9\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$16\frac{3}{4}$	4	33·4	·19	225

in Fig. 67. In the first position (*a*) Fig. 67, the eccentric **E** is at the commencement of its movement in the direction to open the valve, the crank C being still some distance from the dead centre. The steam port is closed by an amount equal to the lap. In the position (*b*) the port is opened by an amount equal to the lead, the crank being on the dead centre. Finally, in (*c*), the eccentric has reached the end of its movement in the direction to open the valve.

Now, from a study of the arrangement of trip gear, Fig. 66, it will be clearly understood that the trip catches will only disengage when the valve is moving in the opening direction. Hence, if the crank has reached the position C (*c*), Fig. 67, before the trip catches have disengaged, they will not disengage in that stroke, and the greatest range of trip will be R.

(*To be continued.*)

FILING SYSTEMS FOR PLANS.

ONE of the chief "Bugbears" which a draughtsman meets with in the course of his daily duties is the many different and crude filing systems for plans in existence in engineering works. Each firm seems to have, in some respect or other, a different method and in cases generally widely different systems throughout.

In some of the old-established firms they rely on systems installed by the old school, which at that time suited their purpose and the size of the firm admirably, but, as in many a case the works and organisations grew considerably, these systems have become obsolete and are not suited to the amount of business transacted nor the size of staffs carried. Again, in some of the most modern new and large companies they rely on systems which have been introduced generally from those in vogue.

The subject is worth consideration, and at little labour and expense upon the employers part in re-organising this small section of their system benefits would no doubt accrue which, at the same time, would have some good effect upon the employees.

In the course of duty when critical parts of a job has been reached, the frame of temper of a draughtsman is not improved when it is constantly occuring that an essential plan of some part of the machine or plant or reference plan cannot be brought to hand or located, which is not at all conducive to good and efficient work. Also, the amount of time absolutely wasted in looking around for a plan when not in place is enormous. Where large staffs are kept and different members are engaged, each on a separate part of a plant, and where standard reference drawings are constantly in use, the person's labour whose duty is to find the plans could be made more easy and profitable by a little forethought and sounder systems. There should be no difficulties in this person not being in a position to drop upon that which is sought for at once, instead of going round enquiring and wading through the rest of the staff's reference drawings and trusting to luck whether he finds what he requires in the first plan he touches or the last.

Perhaps by explaining and commenting upon one or two systems which are in use the reader may be able to form an opinion and come to some conclusion, whereby more efficient systems could be adapted, built up or made better by the addition of some small essential feature to the systems at present in use.

One common system of filing is by cataloguing each plan under its own number and departmental reference, and placing the plans in nests of drawers, the drawers being a little larger than "double elephant" size, each holding say, 25 to 50 plans, the sequence of the numbers of the respective plans being painted or placed on the front of each drawer. This is a fairly good system, and one of the claims for it being a good one is: that it keeps the plans straight and respectable. Personally, I do not think there is much in this, as I have seen in the course of my own experience same very badly damaged plans which have been filed under this system.

Against this system are the following bad features:—

(*a*) Much time has been wasted, and will be wasted again by looking for plans which have been put into

their respective places, but by some means or other have got down the back of the drawers in spite of all necessary precautions and preparations fitted to drawers to prevent this.

(*b*) Plans are generally made on standard sizes of sheets, say, three distinct sizes. The smaller sizes when placed in position in drawers sometimes get to the back, and when being searched for are overlooked.

(*c*) When very large jobs are being carried through which require a great many plans, sometimes a separate drawer is set apart for each particular large order, in addition to numbered drawers. This upsets the sequence of plans in numbered drawers; also, time and labour is lost when the regular searcher is not about, and when the person requiring plan does not know what particular nest of drawers these plans happen to be in. When filing these plans away, instances occur where no name or order number is given on plan, the filer naturally putting them into their order in numbered drawers instead of in the special drawers set apart, entailing extra search when required.

(*d*) Objections to space occupied by large nests of drawers and room taken by plans hanging about which require filing, and which, if not readily filed, are apt to be lost.

(*e*) No facilities arranged for searcher to readily find plan if not in place in drawer. This can be got over by a method explained in a system described later.

A second system is by cataloguing as before and placing the drawing folded in cardboard folios or envelopes in cupboards with sliding or folding doors. The decided views of persons whom have had dealings with this system are interesting—one of them is to the effect that it has been responsible and a great help towards draughtsmen generally acquiring a more easy use of that adjective which is used commonly as a noun in water engineering. On the whole the system is not one to be recommended.

When the plans are folded the numbers of plans are not as readily seen as those filed under the drawer system, whereby more time and labour is entailed putting plans into correct sequence and in finding plans, and it is advisable where this system is in use for the person requiring a plan to look for this himself, as he can readily tell at a glance the plan which he requires (if it is in the folder at all) without referring to numbers, not a profitable occupation by any means for a highly paid member of the staff, who has to leave momentary essential work and search a plan, but, under the circumstances, quicker than leaving the matter in the hands of the regular searcher of the department.

The folders or envelopes for the plans get badly mutilated, torn and generally disabled, and to keep these constantly in good and perfect condition adds additional expense and labour.

A third and perhaps the best system is in use by an old-established firm who introduced the system gradually upon the top of the drawer system, and, as the older plans became less referred to, this became the principal system, little trouble being experienced in the gradual change over.

An objection which may be raised against this system is that, when the tracings are folded into a small size (say a size suitable for a foolscap envelope) and when bold numbers are stencilled on the back of the folded tracing, these folds may show up or the stencilled figures may obliterate a dimension when the prints were again required after the tracing was once folded

This objection may be over-ruled, as from practical experience the inconvenience caused is negliable.

The system is as follows:—Firm's plans are catalogued as before, each folded to one and the same size suitable to go into a foolscap envelope, the size being measured by a gaugestick, which on one side has marked divisions dividing the length of the folded tracing, and on the opposite side divisions giving the width. When folded the plans are then stencilled on the back with their respective numbers in bold black figures in the most suitable position, whereby the figures will not cover a demension or line.

It is then ready for filing, and is placed in a specially made shallow cupboard, the cupboard being fitted with doors and divided up into compartments or pigeon holes, each pigeon hole holding say, 25 folded tracings of about the same size as a foolscap envelope. The size of cupboard is made of such a nature that the top row of compartments are accessible by easy reach from the floor. The division board between each series of compartments and under each compartment has the sequence of tracing numbers painted below. It must be readily seen that the cupboards need not be very large to hold a great many folded plans, nor do they require much space.

It is simply surprising how easily the plans are filed and found under this system; also, the conditions of the plans is no worse after years of service than those in the system previously described.

The filing, folding, searching, etc., in connection with the above system is detailed to the youngest member of the staff, who, when plans have been printed and passed forward to him (after being folded once), has no difficulty in folding the plans again in their original folds and keeping in good order an easy and accessible system, at the same time, whilst performing this duty, becoming acquainted with the class of work upon which he will be engaged at a later stage of his career.

The prints for post and clients are folded in the same manner as the tracings, each suited for a regulation envelope; original plans and 'plans received from clients being catalogued and numbered separately, and filed in similar cupboards as those used for the firm's own plans.

An addition and help may be added to this and other systems, whereby a plan can be located at once, if not in place in cupboard or drawers, by adapting a similar system as used in some tool rooms—that is, by attaching a slate and pencil (to the inside of the cupboard doors or on top of a nest of drawers) on which all plans taken out of place must be recorded by the number of plan and initial of person requiring the same, if, when the plan has once been taken out and recorded, and in the meantime it changes hands, the person whose duty deals with the plan filing system should be informed, and the initial on slate altered to that of the person who is in possession of the plan.

It will be readily seen from this that if a plan is missing, and upon the number being referred to on the slate, the searcher can locate at once the position

of plan, instead of going through the whole rigmarole as at present.

In some cases a card is returned for every plan taken from drawing stores, but these do not help when the drawings change hands after leaving stores.

When plans are returned to cupboards the records on slates being of course removed.

Receptables for plans should not be placed near heating pipes, damp places, or in any position which may have serious effect on useful and valuable records, in which the employers should take a little more interest and appreciate their value better.

This article may be the means of bringing forward others pertaining to different drawing room systems in use, and where they could be improved upon, bearing in mind that there is a great deal to be said for and against all systems, and that the human element can make or mar systems as the case may be, but the real objects in all systems and good organisation is to make the system of such a simple and easy nature that actions become more or less automatic, and motions are eliminated wherever possible.

New Companies Registered.

Arthur Greaves (Lees) Ltd. (158.011).—Private company. Registered August 18th. Capital, £6,000, £1 shares. To take over the business of sheet metal workers, mill furnishers, ironmongers, gas, steam, and heating engineers, etc., carried on by A. Greaves at 82, High Street, Lees, Lancashire, as "Arthur Greaves." Directors : A. Greaves and J. R. Bosworth. Registered office : 82, High Street, Lees, near Oldham.

Mitre Engineering Co. Ltd. (158,249).—Private company. Registered August 26th. Capital, £5,000, £1 shares. Manufacturers of and dealers in motor cars, cycles, ships, boats, launches, and aircraft, electricians, etc. The first directors are to be appointed by the subscribers. Solicitors : Kenneth Brown, Baker, Baker, and Co., Lennox House, Norfolk Street, W.C.

Gulson Engineering Co. Ltd. (158,276).—Private company. Registered August 27th. Capital, £2,500, £1 shares. Manufacturers of and dealers in motor cars, cycles, aircraft, and accessories thereto and parts thereof, etc. The first directors are A. J. Hobbins, G. W. Ravenhall, and A. E. Smith. Solicitors : Browett's, 23, Bayley Lane, Coventry.

Warstone Engineering Co. Ltd. (158,301).—Private company. Registered August 27th, by Jordan and Sons Ltd., 116-17, Chancery Lane, W.C. Capital, £1,000, £1 shares. As title. Directors : C. A. Horton managing director), L. Speak and H. Grainger. Secretary : R. Greenhill. Registered office : 11, Warstone Lane, Birmingham.

Commercial Welding and Engineering Co. Ltd. (158,474).—Private company. Registered September 3rd. Capital, £5,000, £1 shares. To carry on the business indicated by the title and that of manufacturers of motor cars and aircraft, marine and electrical engineers, etc. Directors : J. Thomas and J. E. Thomas. Registered office : 7, Dumfries Place, Cardiff.

Chesham Automobile and Agricultural Engineering Co. Ltd. (158,155).—Private company. Registered Aug. 22nd. Capital, £2,000, £1 shares. To take over the business of motor, agricultural, and general engineers carried on by H. Foster and J. H. Taylor at 99, Waterside, Chesham, Bucks. Directors : H. Foster and J. H. Taylor. Solicitor : M. A. Pritchard, 63-4, Chancery Lane, W.C.

Taylor Brothers (Cannon Street) Ltd. (158,185). Private company. Registered August 22nd. Capital, £10,000, £1 shares. Engineers, founders, fitters, smiths, machinists, and repairers of machinery of all kinds, electricians, mechanical, chemical, and electrical engineers, etc. Directors : A. Atkinson, managing director), H. E. Taylor, A. J. Taylor, and L. Taylor (all permanent). Qualification, £1. Registered office : 46, Cannon Street, E.C.

British Magnesite Calcining Co Ltd. (158,119).—Private company. Registered August 21st. Capital, £100,000, £1 shares. To carry on the business of calciners, burners, grinders, millers, and pulverisers of magnesite, chrome, bauxite, dolomite, or other refractory materials, manufacturers of and dealers in tuyeres, stoppers, nozzles, sleeves, bricks, tiles, and potters, smelters, engineers, etc., and to adopt agreements (1) with Adam Mason and Sons Ltd., and (2) with Woodall, Duckham, and Jones Ltd. The first directors are H. Steel, F. W. Cooper, Col. W. C. Wright, C.B., J. R. Horton, T. Cleworth, Sir Wm. J. Jones, K.B.E., G. Scoby-Smith, and A. Dorman, representing respectively Steel, Peech, and Tozer Ltd., the Partington Iron and Steel Co. Ltd., Baldwin's Ltd., the Steetley Lime Co. Ltd., Adam Mason and Sons Ltd., Woodall, Duckham, and Jones Ltd., Bolckow, Vaughan, and Co. Ltd., and Dorman, Long, and Co. Ltd. Registered office : 14, Great George Street, S.W. 1.

G. M. Hay and Co. Ltd. (10,578).—Private company. Registered in Edinburgh August 14th. Capital, £30,000, £1 shares. To carry on the business of an ironfounder and engineer carried on by George Morrison Hay at Strathcylde Foundry, Arthur Street, Bridgeton, Glasgow, as "G. M. Hay and Co.," and to adopt an agreement with the said G. M. Hay and Co. and G. M. Hay of the first part, and the company of the second part. Directors : G. M. Hay, senior, James Hay, John Hay, and G. M. Hay, junior. Registered office : 86, Arthur Street, Bridgeton, Glasgow.

Brierley Meeson Machine Co. Ltd. (157,951).—Private company. Registered August 15th. Capital, £15,000, £1 shares. Machinists, millwrights, iron and steel converters, brassfounders and finishers, mechanical and electrical engineers, cycle and motor manufacturers of textile machinery, etc. Directors : A. Meeson, H. Mundy, C. Brierley, T. Grainger, and J. F. Berry. Registered office : Cleveland Buildings, 94, Market Street, Manchester.

Buckleys of Sheffield Ltd. (158,120).—Registered August 21st. Capital, £100,000, £1 shares (50,000 preferred). To take over the business of Samuel Buckley and Sons, steel manufacturers and merchants, Sheffield. The vendors are S. Buckley and H. Shaw, and the purchase consideration is £50,000 in ordinary shares, of which £10 000 is for goodwill. Minimum cash subscribed, seven ordinary shares. The first directors are S. Buckley and H. Shaw. Qualification, £3,000. Registered office : 35, Paradise Street, Sheffield.

Trade Items, Notes, &c.

American Blast Furnaces for India.—The American Press reports that two blast furnaces are to be sent from the United States to the Tata Iron and Steel Company, at Jamshedpur, near Bombay, India. A charcoal blast furnace is also being prepared for the State of Mysore, India, and a contract has been accepted to supply a 350-ton blast furnace for the Indian Iron and Steel Company, to be erected 125 miles from Calcutta. The latter company proposes to erect three blast furnaces, by-products coke ovens, benzol plants, and a modern open-hearth steel plant and finishing mills.—*Engineering*.

The Institution of Automobile Engineers.—The first meeting of the Session of the Institution of Automobile Engineers will be held on Wednesday, October 1st, 1919, at the Royal Society of Arts, John Street, Adelphi, W.C., at 8 p.m., when Mr. Thomas Clarkson, M.Inst.C.E., will deliver his Presidential Address. Mr. Clarkson will also deliver his address to the Midland Centre on the following night, Thursday, October 2nd, at the White Horse Hotel, Congreve Street, Birmingham, at 7-30 p.m. A card of invitation to either meeting may be had on application to the secretary of the Institution of Automobile Engineers, 28, Victoria Street, London, S.W.1.

A Market for Motors in Spain.—A second show-room for motor cars will be opened at Barcelona in May, 1920, and it will be well for our builders to carefully note this date, as English cars ought to take a leading place in this exhibition. As great attention is now being paid to motor-ploughs in Spain,

there would also be room for exhibits of that nature, and business would certainly result. The recent demonstrations given in Spain by foreign makers of aircraft ought also to act as a spur to our aircraft industry to get a lead in the Peninsula. The press and the public are all eager for aviation and, as transport in this country is very slow, a service of aerial transport would be welcomed with open arms. Motor boats would also prove popular, and a Spanish journal has been wondering why some firm does not offer such, as "they would have a fine future before them."

Motor Cars in Indo-China.—French motor car builders have been collecting information as to openings for trade in this country, and some of the details obtained are of lively interest. In Cochin-China, the roads are being rapidly improved; 4,000 kilometres, of a width of 4 to 6 metres, are already adapted to motor traffic. The number of cars running in the country shows the following increase: 1914, 530; 1915, 590; 1916, 661; and 1917, 881. The number of cars sold to the Government, and to private persons, from January 1st, 1915, to December 31st, 1918, amounted to 88 and 450 respectively. The cars most in use here are of the following makes: Delaunay-Belleville, Chenard-Walcker, Peugeot, Lorraine, A. Saurer, Dietrich, Charron, Panhard, Renault, De Dion, Clement, Motobloc, Bayard, Darracq, Sizaire et Naudin, Le Zebre, etc., and a certain number of foreign makes. The sellers at Saigon are: Messrs. E. Bainier, Duclos, Société Automobile d'Indo-Chine, Tournier, Perrin, Monod, etc. The war, however, has cost French industry something in Indo-China, as more than half of the cars since then sold there have been of foreign build. Every endeavour is now to be made to alter this state of affairs.

Catalogues of Engineering Goods for Ceylon.—A communication which has recently been addressed to the Colombo Harbour Commission, by the Colombo Harbour Engineer, regarding the failure of United Kingdom manufacturers to supply him with copies of their catalogues, in contrast to a number of American firms from whom he has lately received copies of exceedingly well got-up publications. While it is understood that all orders for supplies required by the Colombo Harbour Commission are placed by the Crown Agents for the Colonies, the Department of Overseas Trade thinks it desirable that United Kingdom firms interested in the supply of harbour materials required in Ceylon should keep the actual users thereof provided with up-to-date descriptive matter relating to their manufactures. It is therefore suggested that catalogues might be addressed by British engineering firms direct to the Harbour Engineer, Colombo, Ceylon, thus enabling this official to keep in touch with the latest developments of the engineering trade in the United Kingdom.—*Board of Trade Journal.*

Revival of Mining in Saxony. From various parts of Saxony, reports are now to hand of the reopening and working of old beds and deposits of ore. This is especially the case in Vogtland where, in former centuries, not only iron, nickel, tin and copper were found, but also considerable quantities of silver and gold. The old gold and silver mines at St. Lampertus, near Hohenstein, were opened and mining work recommenced on August 19th. Several new veins of ores have also been struck in the Wille-Gottes mining region. The veins consist chiefly of iron pyrites, arsenical pyrites and fallow copper ore, all of which are reported to be rich in precious metals. This, however, was the case in former times, but after short working, mining had to be abondoned, as expenses were found to be great; whether this will be so with modern appliances remains to be seen. Meantime, the outlook, though hopeful, does not justify any frantic excitement, although some gold has undoubtedly been already found. In the case of iron it is different; already in the seventies ten pits were working in Vogtland, and one of them passed into the possession of the "Saechsischen Gussstahlfabrik" of Doehlen. This firm has already commenced mining for iron, and satisfactory results have been obtained; brown iron ore is chiefly brought to the surface.

The Institution of Automobile Engineers.—The following list of papers has been promised to the Institution for the forthcoming session. Those members who desire to have a copy of any paper in advance of the meeting, with a view to taking part in the discussion, should notify the secretary without delay. It is hoped to have copies ready two or three weeks before the paper is actually read, so as to give time for members to prepare their remarks:—Presidential Address, by Mr. Thomas Clarkson; "Valve Failures in Petrol Engines," by Dr. L. Aitchison; "Car Design and Car Usage, considered from the Standpoint of the majority of Owner-Drivers," by Mr. E. N. Duffield; "Producer-Gas as supplied to Vehicle Propulsion," by Lieut.-Col. D. J. Smith; "Cast-iron in relation to the Automobile Industry," by Mr. J. E. Hurst; "Some Experiments on Supercharging for High-Speed Engines," by Mr. H. R. Ricardo; "Air-Cooling of Engines," by Dr. A. H. Gibson; "Gear Cutting," by Mr. P. J. Worsley; "Inertia Torque in Crankshafts," by Mr. F. A. S. Acres; "The Final Drive of the Motor-Cycle," by Mr. E. Caudwell; "The Process of Ignition," by Mr. A. P. Young and Mr. H. Warren; "Steel Tubes: their Manipulation and Use in Construction," by Mr. W. W. Hackett; "Volatile Fuel Supplies," by Dr. W. R. Ormandy; "The Single-Cylinder Motor-Cycle Engine," by Mr. N. W. Bowkett; "American Practice," by Mr. A. Ludlow Clayden.

Gas Furnace Temperature Recorder.—A device, the "Falbro" temperature controller, for controlling temperatures in gas furnaces, ovens, lead pots, and other apparatus using gas fuel, has been placed upon the market by the Wilbride Company, Norwood, Pa., and is illustrated in *The Iron Age.* It is operated by air pressure, and consists essentially of the controlling instrument of an automatically-operated valve for gas. The controlling mechanism is made up essentially of a galvanometer and an air motor with clamping mechanism for holding a plate on the galvanometer pointer at intervals of four seconds, when the air is forced through an opening in the plate, thereby causing the valve to operate the gas and air valves to regulate combustion. The position of the air and gas valves is determined by the position of the galvanometer pointer. The needle of the galvanometer, when reaching a point higher or lower than the temperature that has been set, releases the air which operates the valves either to reduce or increase the supply of fuel. In order that the instrument may be set to any desired temperature within the range of the scale, an index pointer is provided. A thermo-couple placed in the furnace to be controlled is connected with the galvanometer. By this method temperatures up to 3,000 deg. Fah. can be controlled; but for higher temperatures the radiation system is necessary. It is stated that the control does not vary more than 1 per cent of the range scale. A multiple control, it is stated, can also be adapted for automatically regulating a furnace having more than one burner.—*Engineering.*

Ship Salvage Problem Solved.—Some valuable and interesting experiments have recently been carried out on the raising of a ship, the s.s. "Main," which was sunk by gunfire from a German submarine in Luce Bay, in the South of Scotland, during the war. The salvage operations were carried out by the Ardrossan Salvage Co., Glasgow, who undertook to test some flexible pontoons, designed, patented, and manufactured by Messrs. Vickers Ltd., Barrow-in-Furness. The pontoons are made of special canvas and cables, and weigh when completed only one ton, yet when inflated with air and submerged in water, are capable of lifting 100 tons. On the trials, two of these 100-ton pontoons were used and fixed to the stern-post of the ship and inflated by means of an air-compressor on a small tug. The vessel was slowly raised and beached ready for pumping out on the 19th instant. The amount of rough handling which these canvas pontoons withstood was remarkable. One great advantage of these canvas pontoons is that when not in use they can be packed into a very small compass and stored in the hold of a salvage ship, and need only be brought out when actually required. The ordinary barges or lighters used for ship lifting are very expensive, both in initial cost and during use. They have to be towed to the scene of operations, and if any bad weather occurs they are in great danger of damage. Very often salvage operations are necessary in order to recover the wrecked salvage gear. From the information gained during these tests, the designers are now confident that pontoons of 200 and 300 tons lifting capacity can be made in the same manner. By the use of this device it will be possible to raise practically any vessel that a diver can reach, and be able to fix such things as shackles, etc., which is a comparatively easy matter, and this eliminates the slow and costly process formerly used. With a little more experience of these pontoons, the designers are confident that they can be increased in size, and it will then become possible to tackle such large ships as the "Lusitania." For instance, they can be made to lift 500 tons each; a battery consisting of about 80 of these pontoons will suffice to lift the ship so that it can be towed into shallow water. It could then be repaired, pumped out, and refloated at high tide.

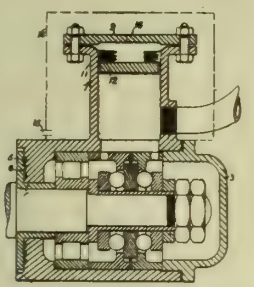
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

BEARINGS.

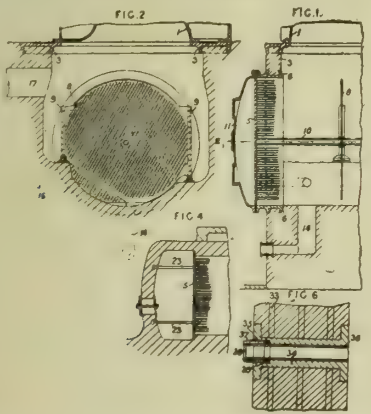
121,491.—J. S. HIGHFIELD, 19, Cottesmore Gardens, Kensington, London.—Jan. 18th 1917.—To exclude water or other liquid from a bearing for submersible electric motors, etc., the casing 3 of the bearing is kept full of lubricant from a reservoir 7 under pressure due to the head of water in which the bearing is immersed and to a spring or weight-actuated piston 12. As shown, a weight 12 is carried by a collapsible bag 11 of wash



leather, etc., the edges of which are clamped beneath a cap 9. An outer casing 14 is provided forming an air vessel, liquid entering at 15, and the air having access to the piston through an opening 16. With this arrangement, the pressure on the lubricant varies with the depth of immersion and always exceeds the pressure of the exteral liquid. A collar on the shaft is formed with projections 5 intermeshing with similar projections 6 on the casing.

CONDENSING STEAM.

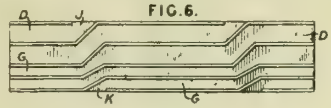
121,510.—A. E. L. SCANES, Strathfield, Harboro Road, Ashton-on-Mersey, and O. R. VERITY, Milford, Bower Road, Hale, both in Cheshire.—Dec. 15th, 1917.—Surface condensers are constructed with a shell or wall made of concrete, ferro-concrete, or other cementitious material or of bricks or other clay material, the tube-plates and water-boxes being secured in or against openings in the shell or wall. The foundations of a turbine or other engine may be made hollow so as to form the shell of the condensers, as in the form shown in Figs. 1 and 2. The steam inlet 3 communicates with the turbine exhaust 1, and outlets 14, 16 lead to the condensate and the air pumps. A free exhaust 17 to the atmosphere is provided. The tube-plates 5 are secured to metallic

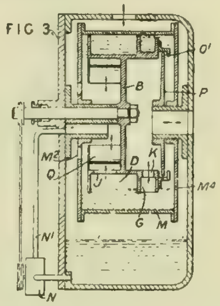


rings 6 grouted into the openings in the foundations. The tubes are supported by sagging-plates 8 mounted on side-supports 9; a stay 10 is provided. Metallic cover-plates may be provided for the water-boxes, or, as shown in Fig. 4, a concrete cover may be formed at one end of the condenser, and the tube-plates 5 may be supported by stays 23. Both the tube-plates and the cover-plates may be secured against seatings in the shell by means of bolts running from end to end of the condenser. The tube-plates may be made of concrete reinforced by metal 33, Fig. 6. The concrete plate is moulded around tubes 34 with flanged ends, of which the outer end 35 is screw-threaded, so that the condenser tube 36 may be secured in position by means of a thimble 37 formed with a flange 38, a fluid-tight joint being formed by packing 39. For abnormally high steam temperatures, the shell of the condenser may be lined with metal, glazed brick, etc.

AIR PUMPS.

121,518.—RANSOMES AND RAPIER, 32, Victoria Street, Westminster, and R. J. CRACKNELL, 61, Babington Road, Streatham, Surrey.—Dec. 19th, 1917.—In a rotary pump in which a rotor B carrying a peripheral, helical channel rotates eccentrically in a casing M in which a liquid piston is maintained by centrifugal action, the channels are formed by parallel walls and are of two widths, each part of uniform width extending aproximately completely round the rotor and the wider channel D opening into the narrower G. Vanes Q assist the entry of the gas through openings M2 to the wider channel D. The narrow channel G is made of less depth

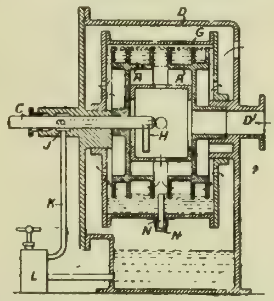




than the wider channel. The inlet J and outlet K of the channel may be in the cylindrical surface as shown in Fig. 3 or on the outer wall as shown in Fig. 6. Liquid is maintained in the casing M at a constant level by a pump N causing continuous flow through the pipe N1 and an overflow opening M4. A liquid seal on the high-pressure chamber is provided by an annular channel O1 on the rotor which dips below the surface of the liquid piston at one point and into which dips the whole periphery of a fixed disc P.

AIR PUMPS.

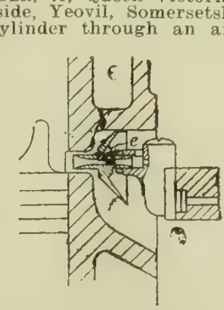
121,519.—RANSOMES AND RAPIER, 32, Victoria Street, Westminster, and R. J. CRACKNELL, 61, Babington Road, Streatham, Surrey. Dec. 19th. 1917.—The circulation of liquid forming the piston between the rotor A carrying a peripheral channel and the eccentric casing G, is maintained by a force set up within the pump. In the pump shown, the spindle C is made hollow and



caries a radial tube H. The spindle is connected by a chamber J to the pipe K and a hand-pump L, which is used at starting and is afterwards cut out. Surplus liquid is discharged from the casing G through the pipe N, which dips into a cup N1. In an alternative construction, the pipe K is led to the inlet passage D1 and the supply of liquid is maintained by the difference in pressures within the casing D and in the suction inlet. The inlet passage may be made conical.

INTERNAL-COMBUSTION ENGINES.

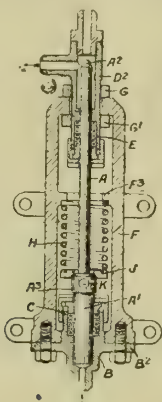
121,556.—E. W. PETTER, 73, Queen Victoria Street, London, and A. M. BROWN, Wayside, Yeovil, Somersetshire.—Mar. 11th, 1918. Fuel entering the cylinder through an air port in its wall is



atomised by some of the air which is intercepted by a cone *f* and directed through ducts *e* into the interior of the nozzle, which is of Venturi form. Specification 10,699/15 is referred to.

VALVES.

121,528.—T. CLARKSON, Woodlands, Galleywood, Chelmsford, Essex.—Dec. 31st, 1917.—A fluid-pressure-actuated valve particularly applicable for controlling the flow of steam to a jet blower used in connection with the furnace of a steam generator is constantly or intermittently oscillated or rotated about its axis to prevent sticking. The valve A2 is formed on one end of a spindle A which is enlarged at its lower end to form a plunger A1. The plunger works in a cylinder B provided with a

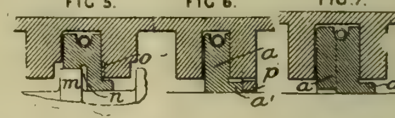


stuffing-box C and is provided with an external flange B2 adapted to be bolted to a forked frame F. The valve chamber D2 is provided with a stuffing-box E and is adjustably secured in the upper part of the frame F by nuts G, G1 engaging screw-threads formed on the outer surface of the casing. A loaded spring H is arranged between a flange F3 on the frame and a plate J having a bevelled hole adapted to engage a conical surface on a boss A3 formed on the spindle. The spindle is oscillated by an arm K screwed into the boss A3.

PACKING FOR ROTATING SHAFTS.

121,622.—SIR C. A. PARSONS, S. S. COOK, and L. M. DOUGLAS, Heaton Works, Newcastle-on-Tyne.—November 19th, 1917.—In order to reduce the inward pressure of a carbon packing ring for a rotating shaft, the ring is formed with a flange *a*1, Fig. 7, which is subjected to the lower pressure only. In order to secure rigidity, the ring may be made broad, the high-pressure edge being recessed as shown. Tilting may be prevented by projections on the ring engaging the flange on the casing at the high-pressure side. In the modification shown in Fig. 5, the ring is stepped and engages a collar *m* on the shaft. The steam in the space *n* is at a reduced pressure and the tendency of the ring to tilt is therefore minimised. A draining groove *o* connected with the low-pressure side may be formed in the flange of the casing in contact with the packing ring. Tilting may be prevented by a projection *p*, Fig. 6, on the casing engaging the end of the flange *a*1 and

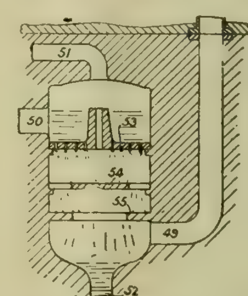
FIG 5. FIG 6. FIG.7.



perforated to permit access of steam to the back of the flange. Alternatively, the projection *p* may be formed on a non-contractile carbon ring interposed between the ring *a* and the flange of the casing. Where the higher pressure may be at either side, two rings *a* are employed with flanges *a*1 facing in opposite directions. The packing may be held in position by bracelet or leaf springs or otherwise.

CONDENSING STEAM.

121,575.—A. E. L. SCANES, Strathfield, Harboro' Road, Ashton-on-Mersey, and C. R. VERITY, Milford, Bower Road, Hale, both in Cheshire.—Jet condensers of the type comprising separate steam and water inlets are constructed with the shell or wall made of concrete, ferro-concrete, or other cementitious material, or of brick or other clay material. The foundations of a turbine or



other engine are made hollow so as to form the shell of the condenser as in the form of counter-flow condenser shown, which is fitted with steam and water inlets 49, 50, condensate and air outlets 52, 51, a distributing plate 53 and baffles 54, 55. Parallel-flow condensers may be used. For abnormally high steam temperatures, the shell of the condenser may be lined with metal glazed brick, etc.

INDEX TO ADVERTISERS.

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Industrial Engineer.

VOL. VIII.] OCTOBER 22ND, 1919. [No. 193.

The Industrial Engineer.

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Published twice monthly, on the 8th and 22nd days, respectively.

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EDITORIAL.

BREEDING TRADITION.

ONE of the strongest things in life—stronger than ethics, far stronger than legal enactment—is the complex tradition which for convenience is termed custom. Nothing in the attitude of any people is more striking or persistent; whether it be cannibalism or a tendency to alcoholic refreshment, custom is stronger than reason. Commerce in general uses the term to denote volume of trade; those who travel through the frontiers of a foreign land find the Customs arbitrary people; in local and international trade custom exerts an influence it is not wise to disregard.

Customs change but slowly; they linger in certain strata of society long after they cease to be practised by those who guide the multitude; fashion is evanescent, but custom dies hard; the more primitive the type, the more is custom a determinant factor. The custom of the country forms a large part of its tradition if, indeed, it is not its outward manifestation. Nationality itself when analysed is largely custom in practical usage. The man in whom we are all interested is the customer who is an individual accustomed to purchase from the right source—ourselves. To foster habit and inculcate prejudice on our behalf is the foundation of business. The difference between a good customer and a bad is one of kind, not degree; it is the difference between a good debt and a bad, not altogether one of trade volume.

There are many customs for which scant justification is forthcoming. In savage society it was usual to kill off all elderly people, they consumed provisions without producing a return; in civilised life the greater the population the larger the number of potential customers; hence the elderly relative gets respite. We are all customers in some relation or other. The island which lived by each citizen taking in the other's washing is an economic truth in a paradox; we are in deed and fact members of a corporate body dependent upon one another. Man is far from rational; he is largely the product of tradition moulded by custom.

There is a natural law universal in its scope which in effect enacts that all living organisms tend to keep doing exactly as their ancestors did, this conception is termed instinct. Domestication alters its strength, but cannot completely eradicate it; the immature human has to be broken in; the process is termed education and training; the budding savage has to be exorcised and primitive traits eradicated. Some never grow up, or wholly divest themselves of taint or atavism, and in the normal and healthy the call of the wild still stirs more sluggish blood.

Apart altogether from inherited tendency, every individual manages to create fetters for himself in the shape of habit. To do so is more or less instinctive, and is wrong only in so far as it binds unduly. The cultivation of good habit is one of the main virtues of training, but after we act apart from control, excrescences develop, and unless watched these may hamper rather than help. There is instinctive judgment the product of experience, which is justified by results; there is also instinctive prejudice unjustified by reason; it is easy to mistake the one for the other and ascribe to sound judgment opinion founded on prejudice. In many respects it is easier to decide offhand because habit has grown unchecked; the tendency against change is always stronger than the desire to alter, and the attitude is in some senses quite correct.

There are instances where practice is contrary to common sense, finds no approval

from reason, but survives where excused on the ground of customary usage. It is easier to repeat than to create, is it not an economic law that repetition and quantity produce low prices. Decay is largely due to the inherent strength of custom, adaptation is proof of life; without the readjustment needed by the passage of time extinction is the unvarying penalty. It is rather appalling, but the expectation of life of the normal firm does not exceed three generations; it will be found, moreover, that in the event of longer survival the existing management bear no relation to the founders. The necessity for new blood is a eugenic law universally operative due to the barriers raised by the passage of time to new idea.

Custom may be good or bad as circumstances indicate; of itself or by itself it is neither excuse nor policy. The least valid argument in a world crammed with excuses is the explanation that "it has always been done that way," as if mere custom were something sacrosanct. As elsewhere, it is wisdom to cling to the tried and proven, discarding the obsolescent and stupid, but impartial consideration is by no means common.

Tradition is not something handed down entire from the past, it is best considered as a progressive revelation; it is more like a plant which grows and thrives under proper conditions, to whose well-being each grain of soil and molecule of air, each vibration of light severally contribute. The heritage we have is a temporary not an absolute possession; we are tenants responsible for due conservation, maintenance and upkeep.

All this may seem to have no very direct bearing upon practical affairs; actually, tradition and the customs which are its outward manifestation have a real as well as a potential value, both present and future. Tradition there must be: then it must be so upbuilt that it aids not hinders; custom will persist, but it can be guided and directed. It is not simply an individual matter nor is it negligible, that any single firm should flout progress. The destiny of a country is determined by the multiplication of isolated issues; prosperous industry is more important than a few outstanding successful firms, and it is here that tradition counts. Mechanical industry in England had a long start over its rivals; it had an unassailed position for a very long period. This is far from true to-day; tradition here at first an asset has become a danger, and revision drastic and complete is sorely needed. Combination will not overset the need for new idea; indications are not wanting to show that in some quarters full attention is being paid to reconstruction in the best sense of that much-abused term, but it is the revival of new tradition in a general sense which is the imperative need.

When the most advanced producers for good and sufficient reason stock their machine shops with tools of alien origin, not on the ground of price, but as they will tell you frankly, by sheer necessity, it is not pleasant hearing or very encouraging to view. Sticking to tradition means very slow advance; experimental method should be more common: this is not a question which affects labour, so much as direction; machine tools which underpin production cannot be installed on sentimental grounds; to do so is to invite disaster. There are doubtless good and sufficient reasons why the machine tool trade showed only an advance of 66 per cent in output during the war; at the present time the dearth approaches a famine, in spite of unprecedented prices higher than ever before. A shrewd American investigator has reported home that his manufacturers have little or nothing to fear from increased competition, due to expansion of the trade here. Supreme as we are in what may be termed engineering sense, itself the product of tradition, we yet have failed to put the needed brains into this field which is the keystone of mechanical production.

Repetition manufacture cannot afford anything but the best; prime cost is secondary to value in service; it is only beginning to be realised that it does pay to scrap before corrosion and decay make this inevitable. Power plant is another story, this gives its own indication in the fuel bill; production methods and machines have to wait competitive cost of product, and the trade is gone before the damage is apparent. Many of the best English tools are either flagrant copies of American machines or are themselves produced by archaic methods by out-of-date plant. It is not pleasant to relate the above, which is certain to arouse opposition from the few enlightened quarters who have broken with tradition themselves, and naturally assume that it is similar elsewhere. Proof, if proof be needed, is in the prosperity of well-known factors and agents whose main business is dealing in imported machines.

Machine tools are one specific instance of the adverse influence of persistent tradition in face o general advance; there are others quite numerous enough to serve as further examples; tradition is fine, but it must be tempered with something else—adaptation to varying need and continuous evolution.

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

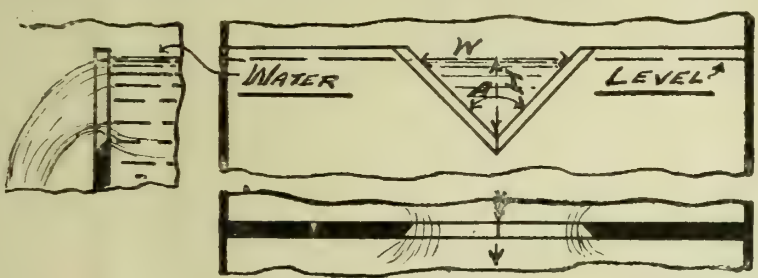
(Continued from page 6.)

The flow of water through the notch can be determined of course by measuring the height of water in the same by means of a pointer connected to a suitable vernier, this checking the accuracy of the recording instrument. For example, the V-notch shown at Fig. 79 has an angle A of 90 deg., and a depth H of four inches. Then the flow in cubic feet per minute from Thomson's formula will be $0{\cdot}305\ H^2\sqrt{H}$, or, say, 3,660 gallons per hour. If the flow is very small and great accuracy is required, notches of a less angle than 90 deg. can be used, the formula will then be $\frac{4}{15}\ k\,W\,H\sqrt{2gH}$ cubic feet per second, W, H and g being in feet. The value of k varies ·59 to ·62 according to angle A, being ·59 for a right angle, g=coefficient of acceleration=32·2. For the measurement of large flows of water rectangular weirs or notch plates are generally adopted, and the flow through same can readily be calculated from Wier tables found in most text books.

Hot Well and Lea Recorder Boiler Feed.

An arrangement of the Lea recorder in connection with boiler feed apparatus is shown in diagram at Fig. 80. As will be seen the feed pump can draw its supply either from the hot well, which is a steel plate covered tank, or from the town's water tank above. By a suitable arrangement of valves as indicated, the recorder can be cut off from pump suction, this forming a very convenient

layout. To make the arrangement quite automatic, that is the flow through the V-notch representing at any moment what is being drawn out of the hot well by the feed pump, it will be necessary to fix a float in the catch-box as shown, this float controlling the supply by a suitable lever and rod connected to an equilibrium valve on the pipe from hot well. More head to pump suction readily cleaned and kept free from dirt, &c. It is advisable to locate the hot well, overhead tank, recorder, &c., as close up to the boiler feed pumps as possible, if there is room available in the boiler house, all the better. The draughtsman must not forget to bear in mind, even on the boiler feed layout, to keep his pipe lines as short as possible.

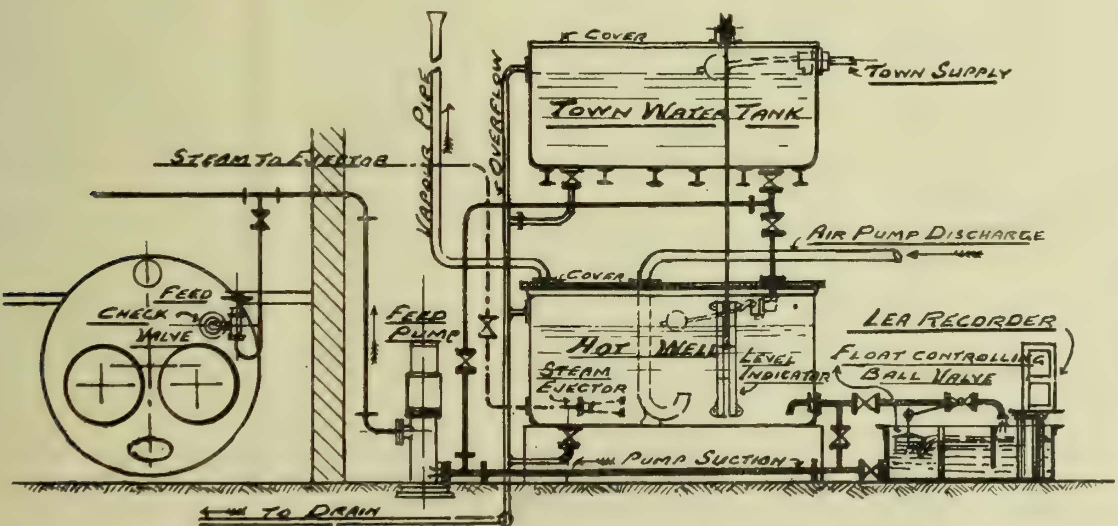


Engineering Lay-out.—Fig. 79.

than shown on diagram is advisable, the hot well and notch tank would be better lifted, say, another foot or two higher, the catch box or end compartment of tank being deeper than the other part of same, so as to contain a good depth below the notch. This will insure the pump not "snoring," or taking in any air due to insufficient head or suction.

As will be noticed, the discharge from the air pump is led into the hot well by the vertical pipe shown, the hot discharge passing up through the water. A steam ejector is also fixed in this tank to raise the temperature of the water when the air pump discharge is stopped, or is not high enough in temperature to effect much economy. As stated earlier on the quantity of steam required for these ejectors is very small, and personally I would always recommend the installing of same in

The most accurate meter for measuring large quantities of water, in the writer's opinion, is the Venturi type. This meter is very suitable, and is largely used for boiler feed measurement, being unaffected by high temperatures or varying pressures. The water is forced through an easy waist or throat in the pipe, as shown at Fig. 81, and when the difference in pressure between the up stream at A, and the throat at B is measured (this difference being known as the "Venturi head") it is only necessary to multiply the square root of this pressure by time and an ascertained coefficient to obtain the total quantity of water passed. Referring to the figure which diagramatically represents the Venturi tube, three glass tubes are shown, one connected to the inlet or up stream at A, one at the throat B, and one at the down stream at C, the tops of all the tubes being

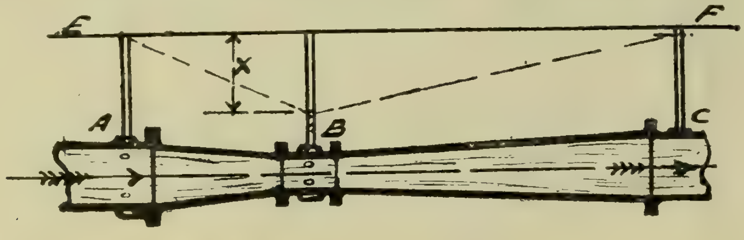


Engineering Lay-out.—Fig. 80.

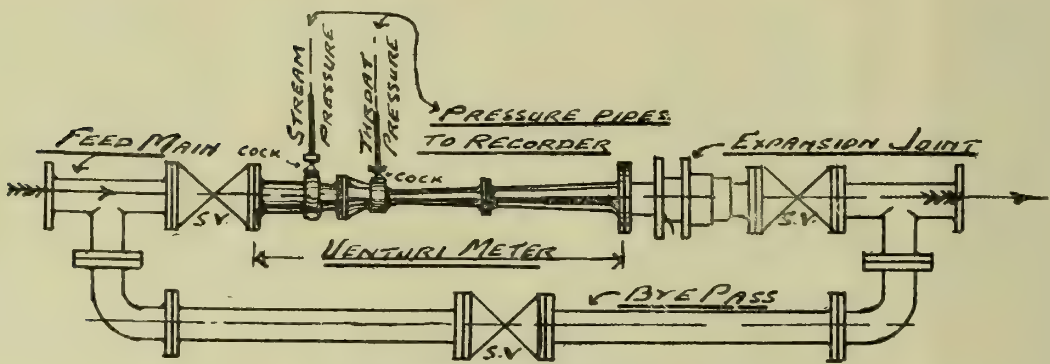
hot well tanks. Both storage tanks are supplied with ball float valves, and a level indicator is connected to the town's supply tank, overflow and drain connections are also provided, as will be seen. The hot well is sometimes sunk below floor level, but it is a better plan to arrange same above ground, as the feed pumps work better under a suction head, and the hot well is more

level. With the water at rest the level in the three tubes will be the same, but when the water is flowing there will be a depression in the gradient at the throat, as shown, and the level or pressure has been nearly regained at the outlet end at C. This is due to the pressure of the water passing through the throat diminishing laterally as it gains in velocity, causing a vacuum or

sucking action, the lateral pressure being restored again as the water reaches the outlet end at C. The difference in levels marked X represents the "Venturi head." The recorder or register is connected to the points A and B by which a continuous record can be made, and quantity taken any time. The recorder chiefly consists of a mercurial U-tube connected with these points, and clock-work mechanism which supplies the time. It is an attractive instrument, and may be fixed on the switch-board platform in the engine room, the meter or Venturi tube being situated in the boiler house near the pumps. When these meters are passing hot boiler feed, the recorder should not be placed within 1,000 feet of the tube, if less than this cooling pipes are recommended. Fig. 82 illustrates the method of installing the tube, this being fixed on the feed main, which may be at any angle, horizontal or vertical. It can be placed close to the feed pumps on either suction or delivery side, but a small head should be on the suction side. A bye-pass on the main is recommended, as shown, to enable the Venturi tube to be removed at any time for cleaning, &c., without holding up the plant, and an expansion joint should be installed as indicated. These meters are only suitable for boiler feeding, &c., and not for measuring condensed steam from air pumps, unless, of course, sent through under pressure. Mr. George Kent, of London, is the maker of this type of meter. Most generating stations and power plants engineers now-a-days recognise the importance of making a check on the steam consumption of their prime movers; also to obtain at any time the correct measurement of boiler feed water, so as to be able to obtain data for checking the cost of evaporation, hence a modern power plant is not really complete and up-to-date without the water meter or recorder. Recorders also indicate by abnormal steam consumptions on the charts the presence of fractures, blade stripping in turbine cylinders, &c., and on several occasions have thus been the means of preventing accidents, this fact alone making them most valuable instruments in the power station.



Engineering Lay-out.—Fig. 81.



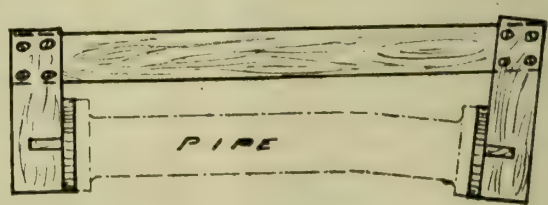
Engineering Lay-out.—Fig. 82.


Fig. 83.

Template Pipes.

However correctly a layout of piping is made, and the pipes themselves faced to exactly the overall dimensions shown on the detail drawing, it will be found in nearly all cases that the last piece of pipe or bend falls short or is too long, hence for the last pipe a "template" is made. This consists of a length of timber on which are nailed two flanges, the flanges being first bolted to the flanges of pipes to be joined up, and then the length of board firmly screwed or nailed to same. The template is now sent to the pattern shop, and then to the foundry, where the pipe is cast off, the flanges should thus meet the flanges on the pipe line. Allowance must be made on the template for machining before going to cast. Fig. 83 shows a timber template, and is often sent into the foundry as indicated, though, for greater precision it would be better reversed, as at Fig. 84; this facilitates moulding greatly.

In making a layout for pipes, especially main steam, the number of template pipes should be kept as low as



Engineering Lay-out.—Fig. 84.

ever possible. Avoid bend pipes for these where you can; straight lengths are sooner got, this being an important point.

It is very annoying for the job to be "hung up" for a template pipe. The erector should always bear in mind that these often take as long as six weeks in some cases to get, especially large bends in solid-drawn pipe. He should have these put in hand as soon as ever the

machine or steam range is in position, and not wait till the best of his part of the job is done.

Template pipes should be clearly indicated by cross hatching on the piping layout drawing, so that the erector can see at a glance the number required, and have them put in hand as the work proceeds.

For cast-iron pipes the templates can be ordered by the erector from a local firm, if one is handy. It is a

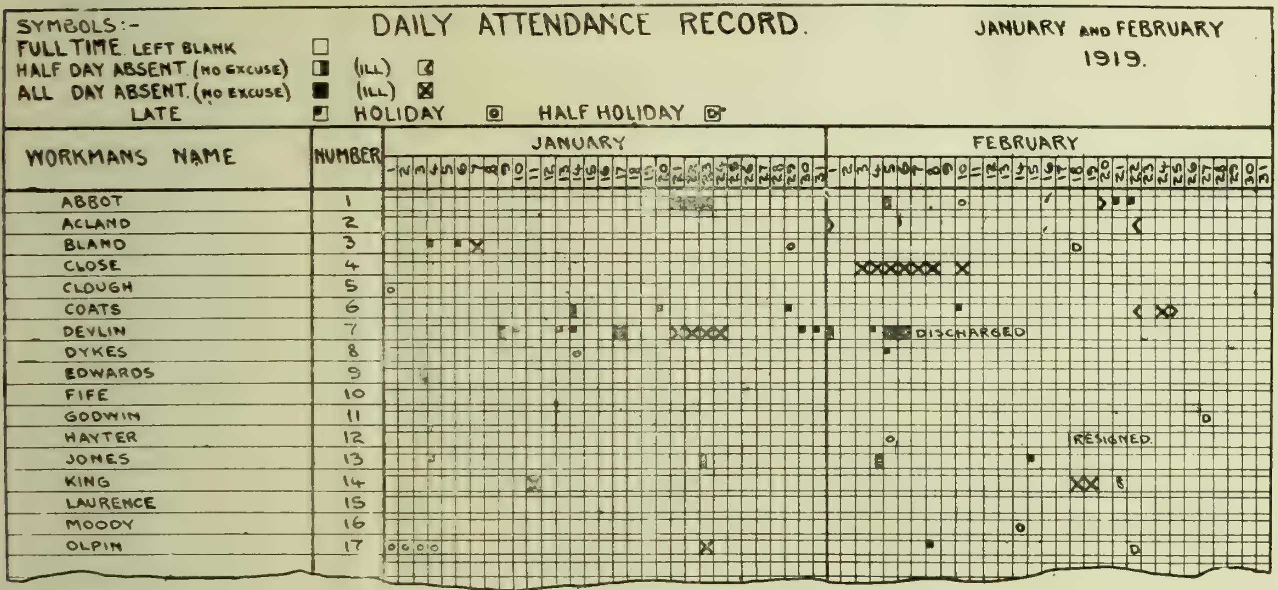
GRAPHICAL AIDS IN MANAGEMENT.

By George Harrison.

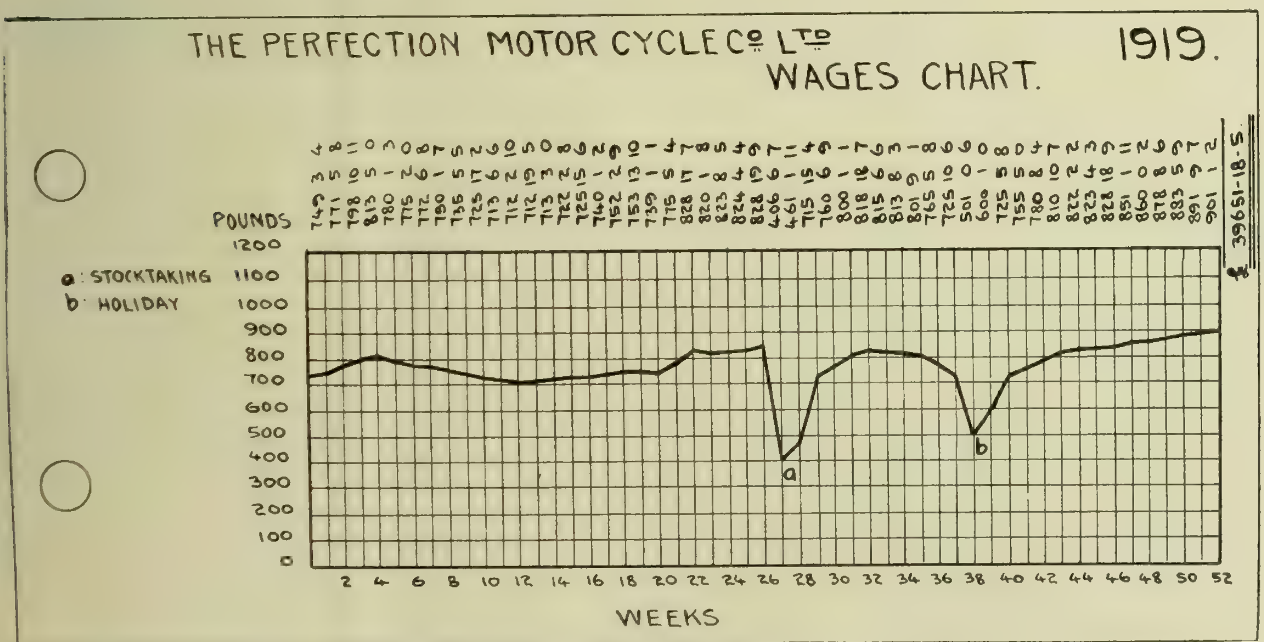
(Concluded from Vol. VII., page 478.)

Works Department.

Works equipment of all kinds is so expensive nowadays that it is essential for the welfare of the business, that it should be worked to its full capacity.



Graphical Aids in Management.—Fig 8.



Graphical Aids in Management.—Fig. 9.

good plan to let these people construct their own templates, as this makes them solely responsible for the correct fitting in of the pipes; even if it means an hour's railway journey for their man, it is worth the while for him to make the template actually from the pipes on the job.

(To be continued.)

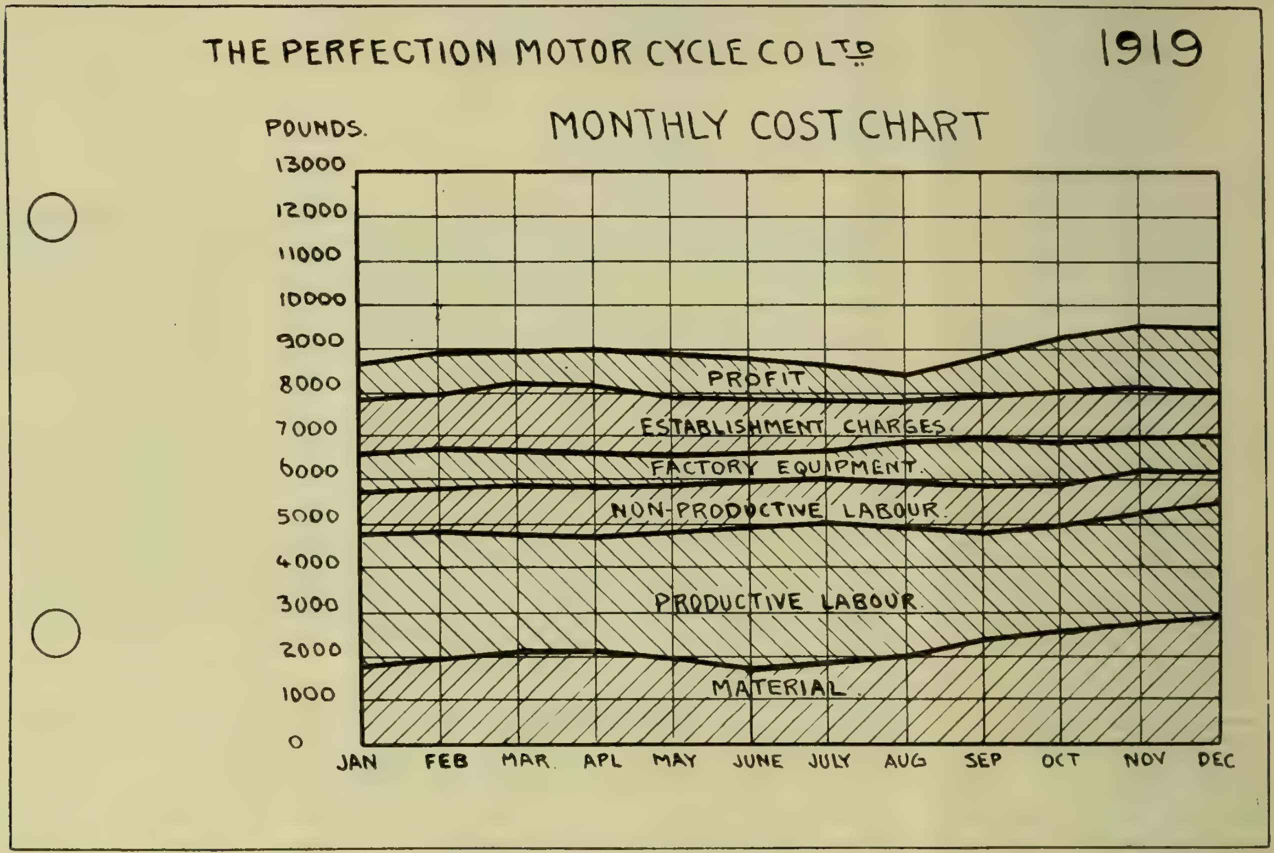
The works department must therefore find the most suitable workpeople for the machines, and having a knowledge of the capacity of each machine tool, can very well form an estimate of the worker's efficiency.

This can be embodied in a chart, especially where the efficiency is settled by the daily bonus being "earned" or "not earned," as in the Taylor

system, or under the piece-work system, where the time is reduced or exceeded.

A similar type of chart can also be used to chart the time-keeping of the workers, see Fig. 8, as an aid to the compiling of accurate records of the workers service, an essential in all management.

A further use for charts is for publicity purposes this manner. Various methods of doing this are illustrated in Figs. 9, 10, and 11. Fig. 9 shows a weekly wages curve that not only gives the exact wages paid, but by the curve shows the upward or downward trend of the wages bill. Fig. 10 illustrates a method showing the expenditure and profit earned for a company, and Fig. 11 is a bar chart which



Graphical Aids in Management.—Fig. 10.

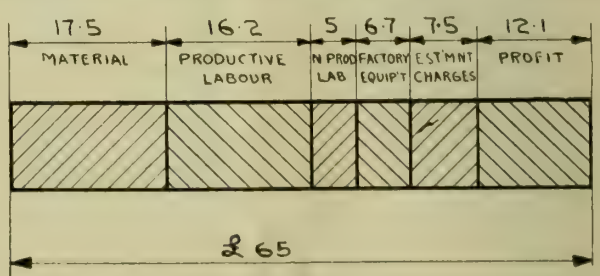
amongst the workers. A variety of purposes will spring to the reader's mind, such as "competitive thrift between workshops," "possible as against actual tonnage produced," or under mass bonus schemes, the rising or falling of the bonus curve.

Plant Department.

This department also has a use for graphical aids, such as charting boiler efficiency in the power house, and temperature curves in the workshops. Another use would be for breakdown frequency charts, enabling the plant engineer to find the weak places in his transmission lines, or the machines which are a source of frequent trouble, and are ready for the scrap merchant or reconstruction.

Cost Department.

It is to the cost department that the management mostly looks for information regarding the soundness and satisfactory progress of the business. This information is usually supplied to them in tabulated items containing many figures, which require careful analysis before correct conclusions can be arrived at. The use of graphical methods, however, in this department are growing rapidly, and every cost accountant should be able to place before his chief the vital statistics of the business in illustrates the actual cost per unit product subdivided under various headings. Other charts can be made showing the monthly unit production costs



Graphical Aids in Management.—Fig. 11.

for the works manager, and thus help him to keep down the costs of the various parts or sub-assemblies manufactured.

(Concluded.)

THE MAGNETIC SCLEROMETER.

Specimens are constructed in the form of rods three inches long and half an inch in diameter. These are given various heat treatments according to the nature of the problem it is desired to investigate. After having been once tested, the same specimen may be

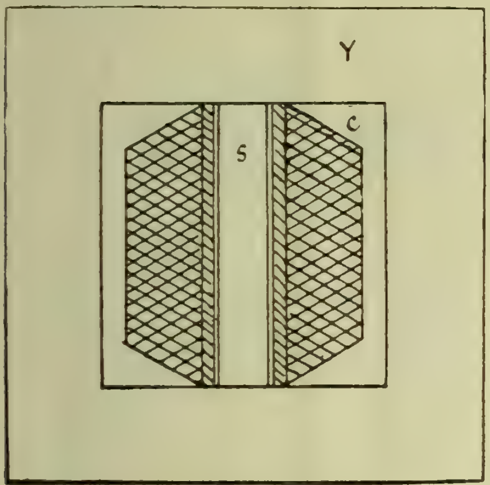


Fig. 1.

retreated and tested again, as it is in no way injured by the test. The method of testing is as follows:—

The specimen is placed inside a solenoid, and the magnetic circuit is completed by the addition of yoke pieces of soft iron. A direct current is flashed on to the solenoid of sufficient magnitude to completely saturate the iron. The specimen is then withdrawn from the magnetising solenoid and is placed in a small search coil which is already connected to a Grassot fluxmeter. The throw of the needle of this instrument indicates the amount of magnetic flux still remaining in the specimen.

When the specimen is of the dimensions indicated, it is shown in the paper that the flux remaining and

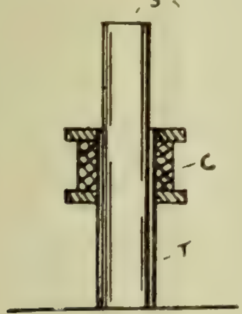


Fig. 2.

registered is strictly proportional to the coercive force of the steel.

The instrument can be directly scaled in C.G.S. units of coercive force, and is being manufactured and sold thus scaled.

The coercive force forms a very convenient criterion for judging the physical condition of steel, as a small change in the heat treatment conditions or composition of the steel results in the production of a much larger change in the coercive force.

The method has been used for the investigation of the following problems:—

The determining of the best conditions for annealing iron and mild steel.

The determination of the critical refining temperature of mild steel.

The determination of the best hardening temperatures for alloy steels.

The effect of overheating carbon tool steel, and the conditions required to restore steel that has once been overheated to its best condition.

The effect of the addition of various substances to quenching water and the effect of raising the temperature of the quenching medium.

The comparison of the quenching power of various oils.

The effect of tempering to various temperatures, more especially on alloy steels.

The approximate analysis of steel in general.

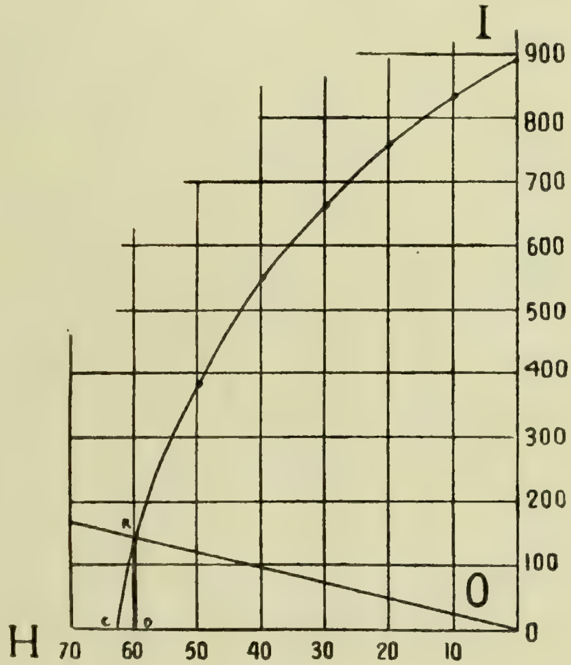


Fig. 3.

The paper contains details of many of these tests.

The magnetising coil is shown in Fig. 1. S is the specimen, C the magnetising coil, and Y is the yoke.

The search coil is shown in Fig. 2. S is the specimen, C is the search coil, which is wound on the tube T.

Fig. 3 explains the theory of the method. The line I C represents the demagnetising curve of a specimen of tungsten steel. O C is the coercive force. O D is the demagnetising force due to the poles. O R is the demagnetising coefficient. The slope of this line is determined by the ratio of length to diameter of the specimen and is the same for all steels, without regard to their physical condition.

The line R D is the quantity of magnetic flux that actually remains in the specimen after it is removed from its yoke. This is the quantity actually measured by the fluxmeter.

Obviously R D is proportional to O C, provided that the specimen is sufficiently short—

O D = .415 × R D (Prof. Silvanus Thompson).
O C = 1.05 × O D (Wild).

With a fluxmeter scaled in units of 10,000 Maxwell turns, the instrument becomes direct reading in terms of C.G.S. units of coercive force, with a winding on the search coil of 275 turns.

It is proposed in future issues of this bulletin to refer further to various experiments and tests made on the thermal treatment of steel, using the magnetic sclerometer as a means of determining the physical condition of the specimen.

The foregoing matter is taken from a paper read before the Faraday Society on July 14th, by Mr. L. W. Wild, M.I.E.E.

WILD-BARFIELD POURING FURNACES.

[Automatic and Electric Furnaces Ltd., 281-283, Grays Inn Road, London, W.C.1.]

The demand for an electric salt bath furnace to which current can be switched on and off as required has led to the development of these makers' "pouring types" of furnaces illustrated herewith. These furnaces can be emptied of their salt contents at any time by simply releasing a safety lock, pulling forward a lever, and pouring the salt into a dry metal container provided for the purpose. The solidified salts, when set, can always be broken up into small pieces and used over and over again continuously.

The great economy and convenience of such a furnace is enormous when work is intermittent, and ensures a method of hardening with a precision and certainty that is unknown by any other process.

Practically every Wild-Barfield furnace has been sold as the result of comparative tests by the purchaser or his agent or on the recommendation of users.

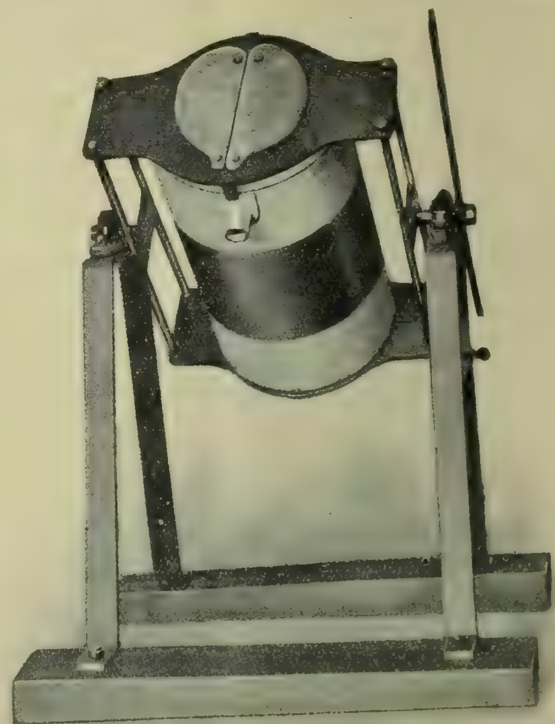
The cost of current consumption and output of various size furnaces is given in the following table:—

Diameter of Furnace in inches .	4″	6″	8″	12″
Max. length of article hardened. .	8	10	12	18
Max. weight of article in lbs.	2	4	10	30
Pounds of Steel per week of 47 hrs. that can be hardened. . . .	470	845	1400	3050
Max. current consumption in watts	1400	2600	4200	9500
Cost in pence per hour with current at 1d. per unit whilst Furnace is working. .	1·4	2·6	4·2	9·5

It will be seen from the above figures that with electric current at one penny per unit, the cost of power comes out to only £3 13s. 6d. per ton of steel hardened.

Electric furnaces offer very great advantages over all other types. The very simplicity of control permits the use of unskilled labour. The ease and certainty of temperature regulation and the absence of fumes cannot be equalled by any other form of heating. To facilitate output and prevent loss of time in works, the makers suggest the introduction of a clock time-switch, so that the current may be automatically switched on the furnace, say, an hour before the arrival of workpeople. This enables immediate work to start at the hour of opening, and practically no delay takes place in preliminary heating up.

In addition to hardening, correct normalising is now playing a most important part, and in some manufacturing operations, normalising is replacing



Wild-Barfield Pouring Furnace.

annealing after forging. This process of accurately heating up to the critical temperature and air-cooling effects a very real economy. It may be stated that independent tests carried out by manufacturers have resulted in the adoption of the process. Furnaces can be seen in operation at the London offices of the firm, where customers' specimens, by appointment, can be hardened.

THE INDUSTRIAL SITUATION.

The outlook in the industrial world is somewhat brighter, particularly in the sections concerned with cotton and coal. In the former industry things are beginning to settle down, and the new arrangement of working hours, taking everything into consideration, looks like being a change for the better. It certainly ought to add to the physical well-being of the operatives, and it should stimulate inventive genius in the direction of improving the productivity of the machinery employed therein. The amount of speculation that is going on would seem to indicate that there would be plenty of employment for some

considerable time to come. Providing we can steer clear of serious disputes, and particularly if the prices of the raw materials come down a little, there should be a prosperous time ahead for both employers and employed in this our staple industry.

Regarding the coal industry, it would be well for the miners if they did not rush too precipitately into the question of Nationalisation. It is a question teeming with difficult problems, and I do not think the present an opportune time for such a drastic move as this would be. Before the mines of this country can be worked economically in the interests of both the nation and its trade, it will be necessary, in my opinion, to first of all reconstruct our transport services in their entirety. Better and more economical transport of materials is the great and important question to-day, and it is the most important for its far-reaching effects. We read daily of congested ports and shortage of transport facilities for dealing with the great mass of imports. There is complaint of the shortage of locomotives, trucks, and rolling stock generally, and until this shortage is made good all trades will suffer from a very serious handicap.

If the statements published in the *Daily Express* are true, it is time something was done in the matter of using the whole of the rolling stock now lying idle. According to the above-named journal, there are "70 powerful engines lying idle at Barnbow, near Leeds," while a further statement says that "the 'dump' at Richborough is a desert of engines, trucks, and rotting stores." If such is the case, it is nothing short of a scandal, and those responsible for such a state of things should be brought to book, and at once.

It is no use crying out for increased production while we neglect to use the facilities we already possess, and which if put into use immediately would act as a stimulant in that direction. Nationalisation conducted on such lines as these is doomed to failure from the very commencement.

One can understand the action of the Government in stopping further work on war craft, because the need for same is no longer existent, but there never was a time when the need for both cargo and passenger-carrying craft was so great as it is at present. In this connection it would seem advisable to divert the displaced labour, caused by clearing the slips, into other channels, and particularly into those channels dealing with inland transport.

Though we may not be pushed for vessels of war, we do need a big addition to our mercantile marine, and we do require an urgent increase in the number of available locomotives and trucks.

Increased production is impossible when there is a shortage of coal, iron, cotton, and other raw materials at the scene of manufacture.

Further, if we are to compete on favourable terms in the world's markets, we shall have to make more and better use of our systems of inland navigation.

The scarcity and dearness of coal will sooner or later force us to pay greater attention to the development of the great water power now so needlessly wasted. Circumstances will combine to compel us to use this neglected force. Our supplies of natural fuel are not inexhaustible, and the way we are exporting such behoves us to economise all we can in this direction, and anything that tends to the conservation of our mineral wealth must be applied to our use without delay.

The recent dispute between the co-operative employees and the various management committees has proved an excellent object lesson for many of those concerned in it. The demands of the employees, particularly with regard to working hours, were thought to be extremely extravagant, and when the matter was carefully considered it was found that there was, for the present at any rate, a limit beyond which it was not safe to go. As a result of this finding, after protracted discussion, the further shortening of hours was dropped altogether. What is true of the distributing trades is in some measure true of all other trades, and it is in the best interests of the industry that the engineering and allied trades should not unduly press this question at the present time. Give the 47-hour week a fair and honest trial, and when production gets to something like normal the question of a further curtailment of the working day might then be safely entered into. In my opinion to force matters on this question would be nothing short of suicidal, and would prove disastrous to all concerned. The total abolition of systematic overtime is a policy every sane workman will endorse, and such abolition in itself has meant a really intelligent conception of what a reasonable working day should be. Overtime is bad for everybody. The workers become stale and jaded, and the increased pay does not recoup them for the loss of health they sustain. Nor has it been altogether beneficial to the employer, and has only been useful to him when contracts had to be rushed to be completed within the time limit. As one who has been compelled to work a very large amount of overtime, I hope and trust that the days of systematic overtime are gone for ever.

Incidentally, labour disputes are not confined to this country alone, but are to be found in every part of the civilised world. Latest advices from the United States of America point to a state of things beside which our greatest strikes are scarcely noticeable. When we hear of a strike involving 350,000 workers, with the possibility of it extending to over a million workers, we can certainly take it for granted that the British worker is no worse than his neighbour. We must all admit that there are extenuating circumstances in his case, and he cannot very well be normal in what are abnormal times.

The scheme for the amalgamation of several of the trades unions in the engineering industry seems more than likly to come to a successful issue. There is a great volume of opinion in the sections referred to that such an amalgamation is a matter urgently necessary to the workers concerned, and is being adopted purely as a means of defence.

After a careful consideration of the whole question, one is forced to admit that it will be far better for all concerned that the whole of the workers in the industry should be members of the same organisation, so that whatever hours and conditions of labour may for the time being obtain, all workers in the trade will participate. Further, it should simplify matters to an enormous extent when negotiations have to be carried on between the representatives of the Union and the representatives of the Employers' Federation. It should also eliminate those sectional squabbles *re* lines of demarcation which have been the cause of so much trouble in times gone by.

Those concerned with the direction and managemen of large establishments, I feel sure, will appreciate this unification of interests, and will know that when they are dealing with the accredited representatives of the workmen of their establishments any arrangement come to will be binding upon the whole, and not a part of them. At any rate, there seems to be every prospect of an overwhelming majority in favour of amalgamation when the ballot now taking place is completed early in October.

The formation of the Industrial League is a step in the right direction, and the recent gathering, whic: brought together such men as the Rt. Hon. A. Chamberlain, J. R. Clynes, J. Wardle, H. E. Blaine, and R. Young, should do much to promote a better understanding, and should also give each side a better idea of the other's point of view. The references at that meeting to the existence of a class war were true in fact and detail, and there will continue to be a class war so long as one class shows its contempt for the other, treating them as inferiors, and by a display of pride and ostentation taking every possible opporunity of belittling those subject to their authority. Not that all the contempt is on one side, by any means. Those whose lot it is to have to do hard manual work have a profound contempt for the man with soft hands and good clothes, particularly when he holds his position by reason of influential connections rather than by personal merit or ability. Get the worker to feel that there is a real dignity in his labour, and that, however unskilled, it is necessary and valuable to the community as a whole, and you will find him giving evidence of finer feeling and greater sensibility than ever he was thought capable of. Continue to treat him as a mere asset in the business, or as an adjunct to a machine, and you will find that, even with the elementary education he now possesses, he will rebel and assert his claim to a better life in a manner likely to shock those of a nervous temperament. Treat the worker as an intelligent and responsible being, and there is no doubt he will respond to such treatment by giving of his best. Then, and not till then, may we bid adieu to a class war.

FOUNDATIONS.

By W. H. Latham.

(Continued from Vol. VII., page 472.)

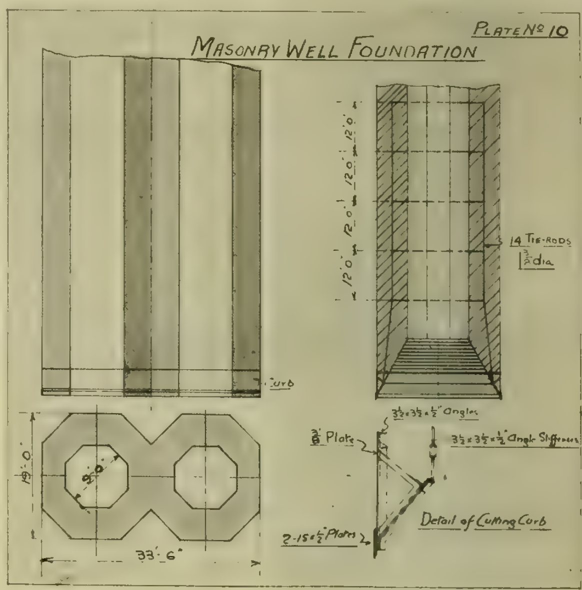
Wells, Cylinders, and Caissons.

For foundations under water three methods are in use:—

(1) The area may be surrounded by piling and pumped out; the foundation being built in the dry. Such foundations are similar to those previously referred to.

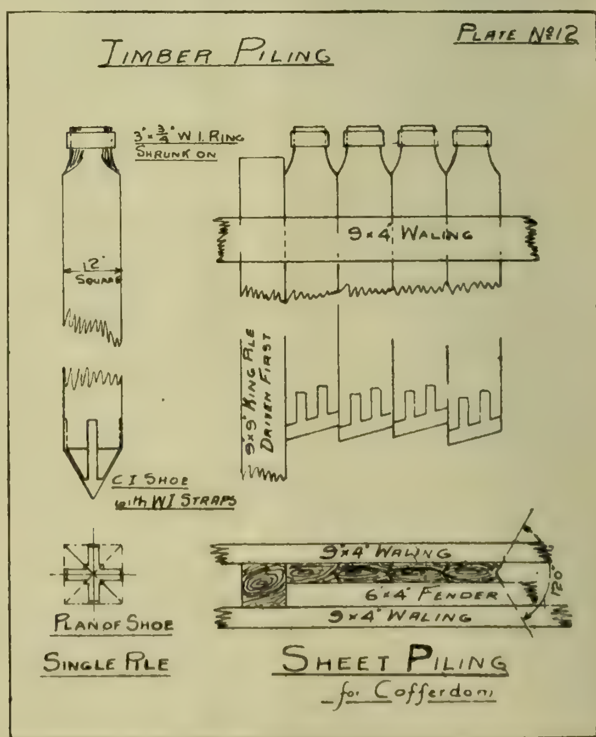
(2) Piles may be driven from above water and the structure built upon them.

(3) A structure may be used which can be sunk into the ground under water while its upper surfaces can be kept above water. These structures are variously termed wells, cylinders or caissons. The wells are largely used in India for river bridges. The dry-weather flow of the river being only $\frac{1}{4}$ to $\frac{1}{10}$th of the flood discharge, the river beds are wide and shallow. They are crossed by bridges having several spans of 90 to 250 ft. resting on piers built up on the wells, which are sunk into the river bed. The well is built of brickwork or masonry on a steel plate curb, which forms the cutting edge, as shown on Fig 10. The section is usually a double octagon or hexagon with two holes resembling



Foundations.—Fig. 10.

wells, from which their name is derived. Through the holes a grab is worked to dig out the material below. The weight of the masonry "steining" forces the well into the ground, and as material is grabbed out, the well is built up as it sinks until a suitable depth is reached.



Foundations.—Fig. 12.

The well shafts are then cleaned out, filled up with sand or broken stone and capped with concrete upon which the pier is built.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 41 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 2 18	7 1 8	10 3 26	14 2 16	0 18 1 6	1 1 3 24	1 5 2 14	1 9 1 4	1 12 3 22	0
1	0 1 13	4 0 3	7 2 21	11 1 11	15 0 1	0 18 2 19	1 2 1 9	1 5 3 27	1 9 2 17	1 13 1 7	1
2	0 2 26	4 1 16	8 0 6	11 2 24	15 1 14	0 19 0 4	1 2 2 22	1 6 1 12	1 10 0 2	1 13 2 20	2
3	1 0 11	4 3 1	8 1 19	12 0 9	15 2 27	0 19 1 17	1 3 0 7	1 6 2 25	1 10 1 15	1 14 0 5	3
4	1 1 24	5 0 14	8 3 4	12 1 22	16 0 12	0 19 3 2	1 3 1 20	1 7 0 10	1 10 3 0	1 14 1 18	4
5	1 3 9	5 1 27	9 0 17	12 3 7	16 1 25	1 0 0 15	1 3 3 5	1 7 1 23	1 11 0 13	1 14 3 3	5
6	2 0 22	5 3 12	9 2 2	13 0 20	16 3 10	1 0 2 0	1 4 0 18	1 7 3 8	1 11 1 26	1 15 0 16	6
7	2 2 7	6 0 25	9 3 15	13 2 5	17 0 23	1 0 3 13	1 4 2 3	1 8 0 21	1 11 3 11	1 15 2 1	7
8	2 3 20	6 2 10	10 1 0	13 3 18	17 2 8	1 1 0 26	1 4 3 26	1 8 2 6	1 12 0 24	1 15 3 14	8
9	3 1 5	6 3 23	10 2 13	14 1 3	17 3 21	1 1 2 11	1 5 1 11	1 8 3 19	1 12 2 9	1 16 0 27	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	
Weight.	0 3·41	0 6·83	0 10·25	0 13·66	0 17·08	0 20·50	0 23·91	0 27·33	0 30·75	0 34·17	0 37·58	0 41	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 41 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0		1 16 2 12	3 13 0 24	5 9 3 8	7 6 1 20	9 3 0 4	10 19 2 16	12 16 1 0	14 12 3 12	16 9 1 24	0
10	0 3 2 18	2 0 1 2	3 16 3 14	5 13 1 26	7 10 0 10	9 6 2 22	11 3 1 6	12 19 3 18	14 16 2 2	16 13 0 14	10
20	0 7 1 8	2 3 3 20	4 0 2 4	5 17 0 16	7 13 3 0	9 10 1 12	11 6 3 24	13 3 2 8	15 0 0 20	16 16 3 4	20
30	0 10 3 26	2 7 2 10	4 4 0 22	6 0 3 6	7 17 1 18	9 14 0 2	11 10 2 14	13 7 0 26	15 3 3 10	17 0 1 22	30
40	0 14 2 16	2 11 1 0	4 7 3 12	6 4 1 24	8 1 0 8	9 17 2 20	11 14 1 4	13 10 3 16	15 7 2 0	17 4 0 12	40
50	0 18 1 6	2 14 3 18	4 11 2 2	6 8 0 14	8 4 2 26	10 1 1 10	11 17 3 22	13 14 2 6	15 11 0 18	17 7 3 2	50
60	1 1 3 24	2 18 2 8	4 15 0 20	6 11 3 4	8 8 1 16	10 5 0 0	12 1 2 12	13 18 0 24	15 14 3 8	17 11 1 20	60
70	1 5 2 14	3 2 0 26	4 18 3 10	6 15 1 22	8 12 0 6	10 8 2 18	12 5 1 2	14 1 3 14	15 18 1 26	17 15 0 10	70
80	1 9 1 4	3 5 3 16	5 2 2 0	6 19 0 12	8 15 2 24	10 12 1 8	12 8 3 20	14 5 2 4	16 2 0 16	17 18 3 0	80
90	1 12 3 22	3 9 2 6	5 6 0 18	7 2 3 2	8 19 1 14	10 15 3 26	12 12 2 10	14 9 0 22	16 5 3 6	18 2 1 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	
Weight.	18 6 0 8	36 12 0 16	54 18 0 24	73 4 1 4	91 10 1 12	109 16 1 20	128 2 2 0	146 8 2 8	164 14 2 16	183 0 2 24	Weight.

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 40 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 2 8	7 0 16	10 2 24	14 1 4	0 17 3 12	1 1 1 20	1 5 0 0	1 8 2 8	1 12 0 16	0
1	0 1 12	3 3 20	7 2 0	11 0 8	14 2 16	0 18 0 24	1 1 3 4	1 5 1 12	1 8 3 20	1 12 2 0	1
2	0 2 24	4 1 4	7 3 12	11 1 20	15 0 0	0 18 2 8	1 2 0 16	1 5 2 24	1 9 1 4	1 12 3 12	2
3	1 0 8	4 2 16	8 0 24	11 3 4	15 1 12	0 18 3 20	1 2 2 0	1 5 3 8	1 9 2 16	1 13 0 24	3
4	1 1 20	5 0 0	8 2 8	12 0 16	15 2 24	0 19 1 4	1 2 3 12	1 6 0 20	1 10 0 0	1 13 2 8	4
5	1 3 4	5 1 12	8 3 20	12 2 0	16 0 8	0 19 2 16	1 3 0 24	1 6 2 4	1 10 1 12	1 13 3 20	5
6	2 0 16	5 2 24	9 1 4	12 3 12	16 1 20	1 0 0 0	1 3 2 8	1 6 3 16	1 10 2 24	1 14 1 4	6
7	2 2 0	6 0 8	9 2 16	13 0 24	16 3 4	1 0 1 12	1 3 3 20	1 7 1 0	1 11 0 8	1 14 2 16	7
8	2 3 12	6 1 20	10 0 0	13 2 8	17 0 16	1 0 2 24	1 4 1 4	1 7 2 12	1 11 1 20	1 15 0 0	8
9	3 0 24	6 3 4	10 1 12	13 3 20	17 2 0	1 1 0 8	1 4 2 16	1 8 0 24	1 11 3 4	1 15 1 12	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Weight.
	3·4	6·8	10·2	13·6	17·0	20·4	23·8	27·2	30·6	34·0	37·4	40	

Weights of Lengths of Rolled Steel Sections.

Beam 8 in. × 6 in. × 40 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 15 2 24	3 11 1 20	5 7 0 16	7 2 3 12	8 18 2 8	10 14 1 4	12 10 0 0	14 5 2 24	16 1 1 20	0
10	0 3 2 8	1 19 1 4	3 15 0 0	5 10 2 24	7 6 1 20	9 2 0 16	10 17 3 12	12 13 2 8	14 9 1 4	16 5 0 0	10
20	0 7 0 16	2 2 3 12	3 18 2 8	5 14 1 4	7 10 0 0	9 5 2 24	11 1 1 20	12 17 0 16	14 12 3 12	16 8 2 8	20
30	0 10 2 24	2 6 1 20	4 2 0 16	5 17 3 12	7 13 2 8	9 9 1 4	11 5 0 0	13 0 2 24	14 16 1 20	16 12 0 16	30
40	0 14 1 4	2 10 0 0	4 5 2 24	6 1 1 20	7 17 0 16	9 12 3 12	11 8 2 8	13 4 1 4	15 0 0 0	16 15 2 24	40
50	0 17 3 12	2 13 2 8	4 9 1 4	6 5 0 0	8 0 2 24	9 16 1 20	11 12 0 16	13 7 3 12	15 3 2 8	16 19 1 4	50
60	1 1 1 20	2 17 0 16	4 12 3 12	6 8 2 8	8 4 1 4	10 0 0 0	11 15 2 24	13 11 1 20	15 7 0 16	17 2 3 12	60
70	1 5 0 0	3 0 2 24	4 16 1 20	6 12 0 16	8 7 3 12	10 3 2 8	11 19 1 4	13 15 0 0	15 10 2 24	17 6 1 20	70
80	1 8 2 8	3 4 1 4	5 0 0 0	6 15 2 24	8 11 1 20	10 7 0 16	12 2 3 12	13 18 2 8	15 14 1 4	17 10 0 0	80
90	1 12 0 16	3 7 3 12	5 3 2 8	6 19 1 4	8 15 0 0	10 10 2 24	12 6 1 20	14 2 0 16	15 17 3 12	17 13 2 8	90

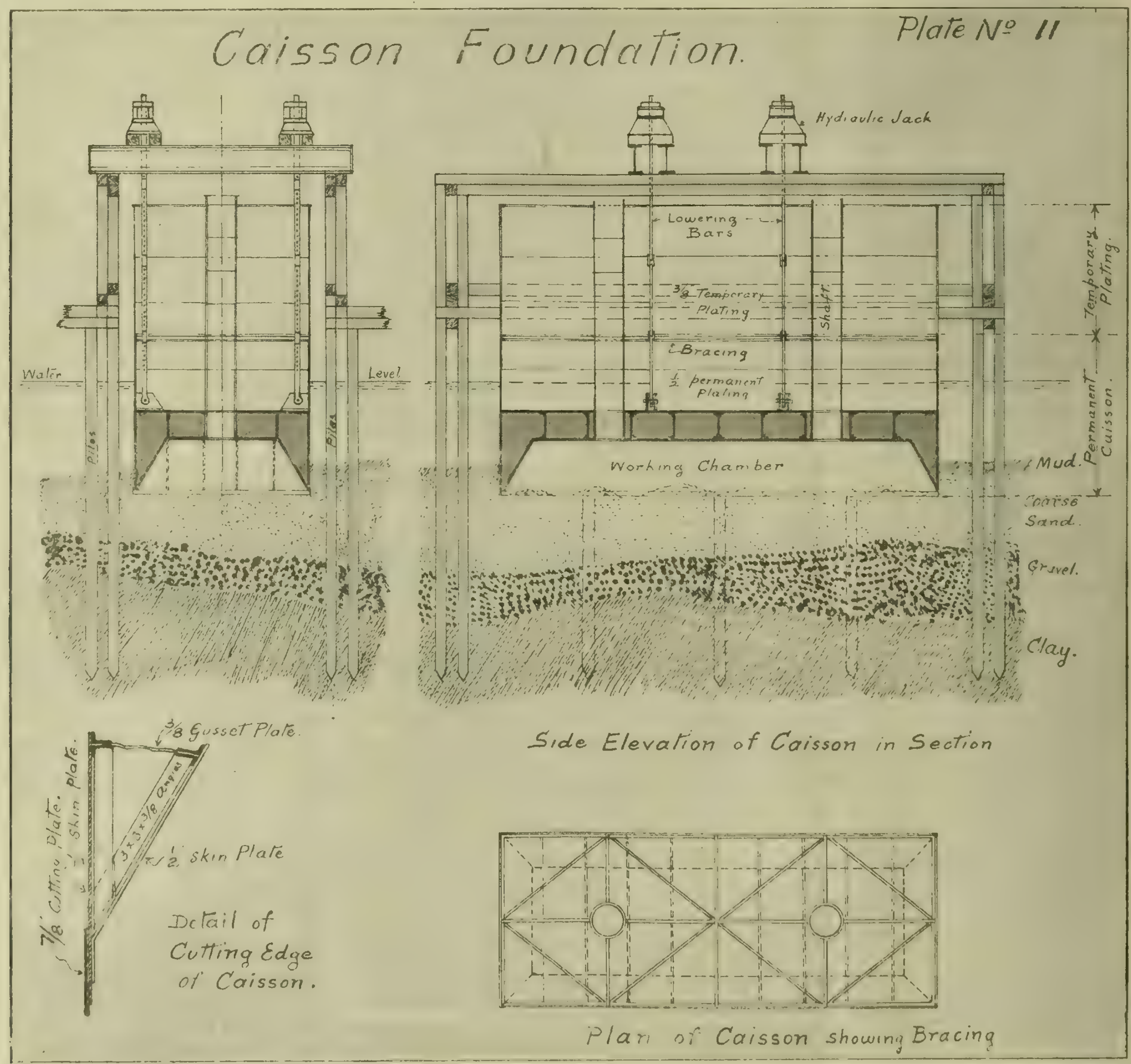
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	17 17 0 16	35 14 1 4	53 11 1 20	71 8 2 8	89 5 2 24	107 2 3 12	125 0 0 0	142 17 0 16	160 14 1 4	178 11 1 20	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

In sinking the well it is convenient to have an exposed surface to start from, and this may be obtained by building an artificial island in the river. In shallow water a ring of sand bags is laid on the bed and filled up inside. For depths over 8 ft. piling may be driven round the site and mats or hurdles used to protect the island till the well has reached the river bed, when the island is allowed to wash away. Where greater depths are to be dealt with the cylinder or caisson is used. The caisson is a double-skinned steel box, the inner skin being tapered out at the bottom to meet the outer skin and form a cutting edge, and a double deck is built over the caisson and the interior filled with concrete. A pile framework is built round the site and the caisson built upon it and then lowered into the river bed. The lowering gear usually consists of slotted rods with hydraulic jacks.

Sometimes the caisson is floated out to site and sunk by flooding it, the material being then grabbed out just as in the wells, the inner deck being omitted. For large caissons, however, tubes with airlocks at the top are fitted, and the water is driven out by compressed air, so that the material can be removed by ordinary methods and the state of the foundation bed observed. The lower part of the caisson is rivetted together with diaphragms and bracing to make a permanent structure, which is filled with concrete and this part is sunk to the ground level. A temporary steel skin with bracing is bolted on above this. When the caisson has been sunk to the required depth the working chamber is cleared out and packed solid with concrete. The air trunks and locks are removed and the lower part filled with concrete to the level of the joint. On this concrete the permanent pier is erected and carried above the water. The joint between the temporary and permanent parts is then disconnected by divers and the upper shell



FOUNDATIONS. FIG 11

removed. This is only done in large caissons. Where the shell is left in place it is sometimes made of cast-iron, and is usually filled up with concrete instead of having a pier built inside it.

The cylinder is merely a special pattern of caisson smaller in size than the regular caissons and circular in section. The use of piling for obtaining a firm foundation is very old.

Piling.

There are Neolithic villages in Switzerland which were built on piles driven into the beds of lakes about 10,000 years ago. Julius Cæsar built a bridge over the Rhine on piles, and Vitruvius, about A.D. 50, specifies their use as follows in his book *De Architectura* :—

> " Take out foundations to solid and dig out marshy soil. If still no solid, pile with oak or olive charred ; drive piles with machine as close as possible and fill intervals with charred wood."

Until quite recent times no other material than wood was used. Cast-iron piles were introduced about 1800 A.D., and W.I. and steel a little later. Reinforced concrete piles have lately come into great favour for permanent work, and special sections of steel are now made for sheet piling.

In addition to its use on permanent work, piling is largely used on temporary work to make platforms, for cylinder and caissons sinking, and for cofferdams to exclude water while permanent foundations are laid. Timber piles are usually square in section except for sheet piles, which are usually about 12 in. by 3 in. The pile is shod with a cast-iron or steel shoe and the head rounded and a hoop shrunk on to prevent splitting, as shown in Fig. 12. In Western America piles are often used without shoes and consist of round trunks with the bark removed. Greenheart piles can be driven into sand without shoes.

(To be continued.)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Continued from page 4.)

Theorem: With any cantilever (see Fig. 15) the deflection at l_1 due to a load W at l_2 is equal to the deflection at l_2 due to a load W at l_1.

In general, if the load W is distant l from the point of encastrément, the bending momen M is W $(l - x)$, and if we put $\frac{1}{I} = f(x)$, where $f(x)$ is any function of x, and apply the standard equation (14), we at once obtain :

$$\frac{E}{W}\frac{d^2y}{dx^2} = l f(x) - x f(x)$$

$$\frac{E}{W}\frac{dy}{dx} = l\int f(x)\,dx - \int x f(x)\,dx$$

say

$$= l\,F(x) - G(x)$$

$$\frac{E}{W}y = l\int F(x)\,dx - \int G(x)\,dx$$

Now integrating the first term by parts, using unity as one factor, and writing H (x) for the second term, there results :

$$\frac{E}{W}y = l\left\{ x\,F(x) - \int x\,\frac{d}{dx}F(x)\,dx \right\} - H(x)$$

$$= l\left\{ x\,F(x) - \int x\,f(x)\,dx \right\} - H(x)$$

$$= l\left\{ x\,F(x) - G(x) \right\} - H(x)$$

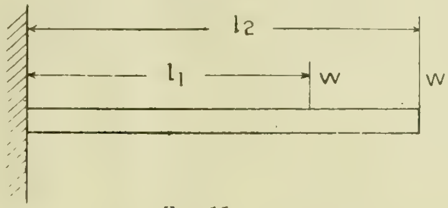


Fig. 15.

Making use of these relations, the deflection at l_1 due to W at l_2 is :

$$l_2\left\{ l_1\,F(l_1) - G(l_1) \right\} - H(l_1)$$

The deflection at l_2 due to W at l_1 is :

$$l_1\left\{ l_1\,F(l_1) - G(l_1) \right\} - H(l_1) + (l_2 - l_1)\left\{ l_1 F(l_1) - G(l_1) \right\}$$

$$= l_2\left\{ l_1\,F(l_1) - G(l_1) \right\} - H(l_1)$$

the same as before; this then proves the theorem.

We may now proceed with the evaluation of the fundametal constants, or A's, for plates with various types of ends or points. The most usual types of

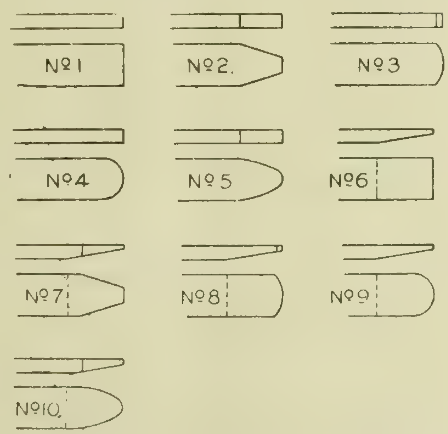


Fig. 16.

points are shown by Fig. 16, and the common names of them are as follows :

No. 1. Square, or plain ;
No. 2. Trimmed, or trapezoidal (trap') ;
No. 3. Round ;
No. 4. Circular ;
No. 5. Parabolic, oval, or egg-shaped ;
No. 6. Square-tapered, or plain-tapered ;
No. 7. Trimmed-tapered, or trapezoidal-tapered ;
No. 8. Round-tapered ;
No. 9. Circular-tapered ;
No. 10. Parabolic-tapered, oval-tapered, or egg-shape-tapered.

There are various other shapes of points in use, but those shown in Fig. 16 are the most common and also the most important. In many cases, the leaves are finished with a slight bevelling of the ends, but this is of no importance from the present point of view, as it is merely a matter of appearance.

Now proceeding to the calculations, the first and simplest case is, of course, that of:

No. 1 or Square Leaf Point.

For this point the leaves are simply cut off "square," and there is no tapering in the width or in the thickness.

For this case, which is simply that of a simple cantilever of uniform section and loaded at the end, if l is the length and y the deflection at the distance x from the point of encastrèment, we have:

$$EI\frac{d^2y}{dx^2} = W(l-x) \quad \text{(22)}$$

$$EI\frac{dy}{dx} = W\left(lx - \frac{x^2}{2}\right) \quad \text{(23)}$$

$$EI\, y = W\left(\frac{lx^2}{2} - \frac{x^3}{6}\right) \quad \text{(24)}$$

and at the end, when $x = l$, we have

$$EI\frac{dy}{dx} = \frac{Wl^2}{2} \quad \text{(23a)}$$

$$EI\, y = \frac{Wl_3}{3} \quad \text{(24a)}$$

and these relations are all that are necessary in order to make the calculations for a spring with the No. 1 or square points to the leaves.

Considering the somewhat extensive abstract work

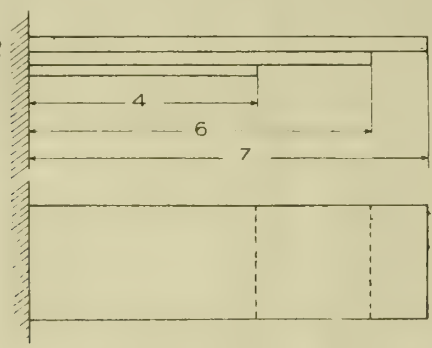


Fig. 17.

of the preceding, it may now be well to give a practical example, showing the application of the foregoing to a particular concrete case. The spring for which the calculations will be worked out is shown in Fig. 17, for which we will take plate No. 1 as 2 in. × $^3/_{16}$ in. with $I_1 = .001099$ and $Z_1 = .01172$; plate No. 2 as 2 in. × $^7/_{32}$ in. with $I_2 = .001745$ and $Z_2 = .01595$; and plate No. 3 as 2 in. × $\frac{1}{4}$ in. with $I_3 = .002604$ and $Z_3 = .02084$. E will be taken as 28×10^6.

Now, in order to calculate the A's we have:

For Plate No. 1.

$$l_1 = 4, I_1 = \cdot 001099,$$

and

$$y_1 = \frac{W_1 \times 4^3}{3 \times 28 \times 10^6 \times \cdot 001099} = \cdot 0006933\, W_1$$

or:

$$A_1 = \cdot 0006933.$$

A_2 is zero always, as mentioned previously, being only introduced for the sake of symmetry of the mathematical expressions.

For Plate No. 2.

$$l_1 = 4, l_2 = 6, I_2 = \cdot 001745,$$

and

$$y_3 = \frac{W_1 \times 4^3}{3 \times 28 \times 10^6 \times \cdot 001745} = \cdot 0004366\, W_1$$

or

$$A_3 = \cdot 0004366$$

$$y_4 = y_3 + (l_2 - l_1)\frac{dy}{dxl_1}$$

$$= \cdot 0004366\, W_1 + \frac{2 \times W_1 \times 4_2}{2 \times 28 \times 10^6 \times \cdot 001745}$$

$$= \cdot 0004366\, W_1 + \cdot 0003275 W_1$$

$$= \cdot 0007641 W_1$$

or

$$A_4 = 0007641.$$

$$y_5 = \frac{W_2 \times 6_3}{3 \times 28 \times 10_6 \times \cdot 001745} = \cdot 001473\, W_2$$

or

$$A_5 = \cdot 001473.$$

From the theorem given above:

$$A_6 = A_4 = \cdot 0007641.$$

For Plate No. 3.

$$l_2 = 6, l_3 = 7, I_3 = \cdot 002604,$$

and

$$y_7 = \frac{W_2 \times 6^3}{3 \times 28 \times 10^6 \times \cdot 002604} = \cdot 0009875\, W$$

or

$$A_7 = \cdot 0009875.$$

$$y_8 = y_7 + (l_3 - l_2)\frac{dy}{dxl_2}$$

$$= \cdot 0009875\, W_2 + \frac{W_2 \times 6^2}{2 \times 28 \times 10^6 \times \cdot 002604}$$

$$= \cdot 0009875\, W_2 + \cdot 0002469\, W_2$$

$$= \cdot 001234\, W_2$$

or

$$A = \cdot 001234$$

$$y_7 = \frac{W_3 \times 7^3}{3 \times 28 \times 10^6 \times \cdot 002640} = \cdot 001568\, W_3$$

or

$$A_9 = \cdot 001568.$$

From the theorem:

$$A_{10} = A_8 = \cdot 001234.$$

(*To be continued.*)

NOTES ON OPERATING ALTERNATORS.

Much trouble was frequently experienced in the early days of electricity supplies when attempts were made to operate two or more alternators in parallel. Owing to the introduction of the steam turbine, these troubles have been greatly minimised, but the parallel working of alternators is necessarily less simple than the parallel operation of direct-current dynamos. Two dynamos may be connected in parallel when their voltages are equal, and their loads may be regulated at will by manipulating the field rheostats, but two alternators can only be connected in parallel when they coincide in voltage,

phase, and frequency. The frequencies of two machines will be equal when the product of the number of poles and speed (in revolutions per minute) of one machine is equal to the product of the number of poles and speed of the other machine, and they are in phase when the positions of the poles in the two cases are identical. When these conditions have been fulfilled, it is safe to connect two alternators together. The state of synchronism may be indicated by a synchroscope, a voltmeter, or by lamps, a synchroscope being preferable on account of the fact that it shows whether the machine about to be paralleled is running too fast or too slow.

When two alternators have been connected in parallel, the field rheostats must be properly adjusted, for otherwise cross-currents will circulate between the two machines and through the windings, thus raising the temperature and lowering the useful output. The excitation is correct when the idle or cross-current has been reduced to a minimum. Generally speaking, the change in the field current when machines are working in parallel should be the same as when they are working separately under the same load and voltage conditions. The wattless current circulating between two alternators as the result of incorrect excitation leads in the winding of the machine that is under-excited and lags in the winding of the machine that is over-excited, and the effect is that the field of the former machine is strengthened and the field of the latter weakened. Provided the excitation of the two alternators is not far from correct, the cross-current will be excessive and the increased I^2 R drop will be inappreciable, but if the exciting current deviates widely from the correct value, then the cross-current may be sufficient to open the circuit breakers, notwithstanding that the actual load is small.

If two alternators are connected in parallel when they are out of phase, then the local current between the two machines may be great, for if the maxima of the pressure waves do not occur at the same moment, a current circulates between the two machines under a pressure equal to the difference between the two voltages. If, owing to a mistake having been made in connecting up the synchronising instrument, the machines be connected in parallel when they are 180 degrees out of phase, then the pressure available for sending cross-currents through the windings will be twice the normal busbar pressure. The older tyes of machines, such as Mordey and Ferranti alternators, were very sensitive to any phase difference, owing to the low impedance of the armatures, but modern machines, having the armature coils embedded in an iron core, are far superior in this respect. Modern alternators will stand short circuits, and have been switched into parallel in direct opposition, but with the best of alternators this is dangerous, and every precaution should be taken to prevent machines being switched into parallel when they are out of phase. Although it is not necessary that all alternators that run in parallel should be of the same type, it is nevertheless true that machines that are identical operate most satisfactorily in parallel. If two alternators have pressure waves of different forms, cross-currents will always circulate between the two machines, but unless the wave forms are very much different, the resultant circulating currents do little harm apart from causing additional heating and slightly lowering the efficiency.

It is very important that the turning moment of prime movers driving alternators should be as uniform as possible, otherwise cross-currents will surge between the alternators, and when this occurs alternators are said to hunt. If this hunting or swinging be allowed to exceed a certain amount, the regulation of the machines may become unstable and they may break out of step. With steam turbines and high-speed generators having few poles, this trouble seldom occurs, but with reciprocating engines hunting has often been difficult to avoid. If one of two machines running in parallel momentarily lags behind the other, the armature of the lagging machine receives a current from the other alternator, and this current tends to pull the lagging machine into phase. This, of course, necessitates accelerating the lagging machine, which may then send current into the other machine which was previously leading, and the result is that the alternators alternatively lag and lead, and are said to hunt. The engine that is being accelerated by the other engine will have its supply of steam reduced by the governor, and if the governor is too sensitive it may cut off too much steam. A moment later the overgoverning will be in the opposite direction, and as the other engine will behave in a similar manner, the steam supply becomes periodic instead of constant. A perfectly uniform turning moment cannot be obtained with reciprocating engines, but cross-currents arising from the cyclic irregularity can be greatly minimised by the use of suitable flywheels, which store and restore the intermittent energy during the course of each revolution. The flywheel effect must not, however, be too great, otherwise the flywheel may prolong hunting when once it is started.

The governors of reciprocating engines driving alternators should be capable of responding to the small and quick variations of speed such as occur during a single revolution, and they should be constructed so that there is no tendency for them to cause a periodic transfer of load between one alternator and another. The result is accomplished by fitting the governors with suitable dashpots, so that the action is to some extent sluggish and will not permit of the steam supply being varied unless the force acting on the governor is maintained for a certain period. In the days when the conditions necessary to avoid hunting were improperly understood, and when considerable difficulties in getting alternators to run in parallel were often experienced, it was occasionally found beneficial to synchronise alternators so that all the crank shafts were in step with the result; that the variations in the turning moment of each engine were coincident. But at the best this was not a very satisfactory method of overcoming the difficulty, owing to the fact that it often took a considerable time to get the cranks into step. Moreover, although the practice of getting the cranks into step may eliminate hunting of the generators themselves, it does not necessarily prevent hunting occurring between the generators and sub-station machinery. The hunting of generators and converters has been greatly minimised, in many cases, by fitting such machines with copper dampers, surrounding the poles of the field magnets

or by copper grids embedded in the pole faces. Owing to eddy currents being induced in the copper, the effect is the same as introducing mechanical friction and the tendency to hunt is checked. Alternators having solid poles are, as a rule, less liable to hunt than those having laminated poles, which naturally impede the flow of eddy currents.

The engines driving alternators should have the same characteristics, otherwise the load will not be equally divided between the alternators working in parallel. The same load on any engine should produce the same drop in speed, but the governors must, of course, be capable of adjustment to enable the machines to be synchronised and to enable the load to be transferred from one machine to another. If a governor gets out of order and does not respond properly to changes of load, then parallel operation will naturally be imperfect, and hunting is liable to occur. There are two reasons why turbines are much more suitable for driving alternators than reciprocating engines. One is that the turning moment is much more even, as already explained, and the other is that the angular irregularity of a turbine has a much smaller percentage effect on the pressure wave, on account of the small number of poles and the relatively large pole pitch.

CAMS.

By W. E. Bennison, A.M.I.M.E.

(*Continued from Vol. VII., page 468.*)

Velocity of the Follower.

The cam curve may be so shaped as to give any kind of motion—within limits—which is desired. The velocity of the follower may be fast or slow; uniform or irregular; it may be changing constantly according to a definite law; or it may be changing in an irregular manner. As was shown in the previous analysis the velocity of the follower is a function of the slope of the curve; the steeper the curve the greater the velocity. It is the speed of rotation in relation to the slope of the curve which determines the velocity. If the speed of rotation is constant and the slope of the curve constant the velocity of the follower will be constant. If the speed of rotation is constant and the slope of the curve changing the velocity of the follower will change. There are several standard forms or types of motion in common use. Three of the most common will be briefly described.

The *uniform velocity* cam is one of the most common forms and one of the most easily understood. When cams are shown in text books this is usually the type given. It is used when it is desired to move the mechanism at a constant speed, and where uniformity of speed is of more importance than anything else. The automatic turning machine affords a good example of a machine where this form of cam is used. It is necessary for the tool to travel at a uniform rate of speed in order to obtain a chip of even thickness and get a good finish on the job. This form of cam cannot be used for high speeds or heavy loads.

When the speed of the moving parts requires to be high or when the load is great it is usually necessary so to proportion the cam as to avoid the excessive inertia forces which may be set up. If, say, a rapidly moving reciprocating piece is required to attain its full velocity immediately after reversing the inertia loads may be so great as to destroy the mechanism. In an aeroplane engine the valves are operated at a very high rate of speed by cams: if these are not correctly shaped the rollers will bounce up and down from the cam faces and slightly open the valves against the pressure of the springs, causing backfiring, loss of compression, and other troubles. In addition, the hammering effect is injurious and fracture may ensue. Or to take another case, in a machine where a heavy load has to be taken up quickly, such as a punching machine, the inertia forces will also be detrimental. Excessive wear will take place, flats be worn on the cams and rollers, and injurious stresses set up. It follows that when the inertia forces are high the speed of the machine must be kept down.

The method adopted to deal with this difficulty is so to shape the cam that the load is taken up gradually: the velocity of the follower is made very slow at the commencement of the stroke, gradually increasing to the maximum, and then decreasing to nothing again at the end of the stroke. Two standard cam forms are in common use for this purpose.

The *harmonic motion* curve cam gives a harmonic velocity to the follower. The classic examples of this type of motion are, of course, the pendulum, and the piston coupled to a uniformly-rotating crank by an endless connecting rod.

The *constant acceleration* curve cam, as its name implies, gives to the follower a velocity which is constantly accelerated. A body falling from rest would have constant acceleration. If it were desired to slow the follower down gradually from its full velocity it would be given constant retardation. A body projected vertically upwards from the earth would have constant retardation.

Other curves may be adopted for the purpose in view. Which curve is used is mostly a question of individual preference. The two curves which have been described above give a natural free motion, and very good results are obtained from them.

The velocity of the follower may have to vary to suit the requirements of the machine of which it is a part: it may be a combination of the above motions or others, or it may be entirely irregular. In any case the cam curve will have to be shaped to give the correct motion. This is the point which it is desired to bring out here, that it is the form of the curve which determines the velocity of the follower.

Design of Cams.—How to lay out Cam Forms.

The principles involved in laying out cam forms are simple and are the same for all cases. In describing the methods it will, of course, be necessary to assume certain particulars such as the shape and size of the follower, the length of its stroke, and the kind of velocity to be given to it; the relation of the follower path to the cam axis; the angular movement of the cam, and the direction of motion of both.

The procedure is as follows:—

A point is fixed to represent the axis of the cam; the path of the follower is laid down in its correct relation to that axis, and the follower assumed to be at the commencement of its stroke. The cam is imagined to have uniform velocity and it therefore sweeps through equal angles in equal times. The rotation of the cam

through a certain angle causes the follower to move from one end of its path to the other. The procedure is to revolve the follower path with uniform velocity round the axis of the cam in a direction opposite to that of the cam's rotation, the angle of revolution being equal to the angle through which the cam must rotate to give to the follower the required stroke: at the same time the follower is made to move along its path with its correct velocity. The *locus* of the follower centre derived from these two motions is the true cam curve.

In the examples which follow the investigation will be confined to:—

Spiral cams; helical cams.

Roller contact; surface contact.

Uniform motion curve; harmonic motion curve; constant acceleration curve.

(To be continued.)

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(*Continued from page* 15.)

The steam valve diagram is shown in Fig. 68. B C is the circular travel of the valve, C D the lap, A D the lead. The port opening from the position O T (admission) to O E (latest trip) is shown for several points by the radial intercept p. For instance, at the crank position O F, revolving clockwise, the port opening is O S. The governor has to overcome the frictional resistance of the trip catches. Table 13 gives the leading dimensions of three trip gears of this type, with the controlling force of the governor measured at the point of engagement of the trip cams. The same governor was used for the 12-in. and 20-in. sizes, and a smaller governor for the 7-in. cylinder, the design being already shown in Fig. 29 with or without compensating gear.

Calculations for Controlling Force.

Small Governor for 7-in. Cylinder.—Without compensating gear:—

Diameter of ball, $3\frac{3}{4}$ in.; width, $2\frac{1}{4}$ in.; weight, $5\frac{1}{4}$ lbs.; weight of counterpoise, 112 lbs.

To weight of ball add half weight of two link arms, making total weight, $6\frac{1}{2}$ lbs.

Radius to centre of ball at mid-position, $6\frac{3}{4}$ in. = .562 ft.

Centrifugal force of one ball at mid-position and 300 revolutions per minute, $6.5 \times .562 \times 300 \times 300 \times .00034 = 111.5$ lbs. Centrifugal force of two balls, 223 lbs.

Controlling force at balls, $.02 \times 223 = 4.46$ lbs.

Arm of centrifugal force about instantaneous centre, 9 in.

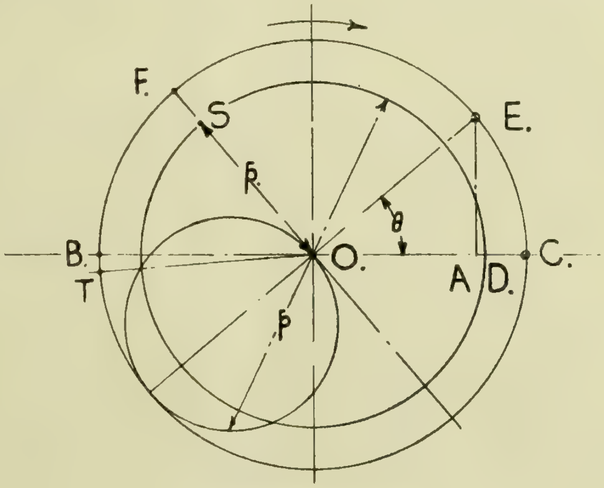
Arm of controlling force at sleeve, $16\frac{7}{8}$ in.

Controlling force at sleeve, $\frac{4.46 \times 9}{16.875} = 2.38$ lbs.

Lift of governor, $1\frac{3}{4}$ in. Movement of trip-rod, $1\frac{1}{4}$ in.

Controlling force along trip-rod, $\frac{2.38 \times 1.75}{1.25} = 3.33$ lbs.

Length of trip lever, $3\frac{3}{8}$ in. Radius of trip cam, $\frac{3}{4}$ in.



Governors.—Fig. 68.

Controlling force at circumference of trip cam, $\frac{3.33 \times 3.375}{.75} = 14.9$ lbs.

Large Governor for 12-in. Cylinder.—Without compensating gear:—

Diameter of ball, $4\frac{3}{8}$ in.; width, $2\frac{5}{8}$ in.; weight, $8\frac{1}{4}$ lbs. Weight of counterpoise, 172 lbs.

To weight of ball add half weight of two link arms, making total weight $10\frac{3}{4}$ lbs.

Radius to centre of ball at mid-position, 9 in. = .75 feet.

Centrifugal force of one ball at mid-position and 250 revolutions per minute, $10.75 \times .75 \times 250 \times 250 \times .00034 = 171$ lbs. Centrifugal force of two balls, 342 lbs.

Controlling force at balls, $.02 \times 342 = 6.84$ lbs.

Table 13.

Working Pressure.	Diameter H.P. Cylinder.	Diameter Steam Valve.	Diameter Exhaust Valve.	Steam Lap.	Exhaust Lap.	Valve Spindle Diameter.	Arm of Valve Lever. Valve End.	Arm of Valve Lever. Dashpot End.	Trip Die. Width.	Trip Die. Depth of Engagement.	Diameter of Trip Cam.	Pull on Dashpot Spring.	Controlling Force of Governor Measured at Trip Cam.	Bevel Wheels for Governor Drive.
Lbs. per sq. in.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Lbs.	Lbs.	
150	7	2	2	$\frac{3}{16}$	None	1	$2\frac{3}{4}$	$2\frac{3}{8}$	$1\frac{1}{2}$	$\frac{5}{32}$	$1\frac{1}{2}$	60	15	$\frac{3}{4}$ in. pitch $1\frac{3}{4}$ in. wide
150	12	$3\frac{1}{2}$	$3\frac{1}{2}$	$\frac{1}{4}$	$-\frac{1}{32}$	$1\frac{3}{8}$	$3\frac{3}{4}$	3	2	$\frac{3}{16}$	2	110	17	
150	20	$4\frac{1}{2}$	$5\frac{1}{2}$	$\frac{3}{8}$	$-\frac{1}{16}$	2	$5\frac{1}{2}$	$4\frac{1}{2}$	3	$\frac{1}{4}$	$2\frac{3}{4}$	130	20	$\frac{7}{8}$ in. pitch $2\frac{1}{4}$ in. wide

Arm of centrifugal force about instantaneous centre, 12 in.

Arm of controlling force at sleeve, $22\frac{1}{2}$ in.

Controlling force at sleeve, $\frac{6.81 \times 12}{22.5} = 3.65$ lbs.

Lift of governor, 3 in. Movement of trip-rod, $3\frac{1}{4}$ in.

Controlling force along trip-rod, $\frac{3.65 \times 3}{3.25} = 3.37$ lbs.

Length of trip lever, 5 in. Radius of trip cam, 1 in.

Controlling force at circumference of trip-cam, $\frac{3.375 \times 5}{1} = 16.85$ lbs.

(To be continued.)

JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By Herbert C. Armitage, of Birmingham, Associate Member.

(Continued from Vol. VII., page 475.)

Financial Aspects of Manufacturing Improvements.

There is another item worth notice, which applies only to a component which is in continuous manufacture. Let it be supposed that by the methods already in use, each piece costs 100d. to manufacture, and that by designing certain tools it were possible to reduce the cost to 95d. What amount would be justified in plant expenditure in order to effect this saving? The gain obviously would be 5 per cent (apart from a possible increase in selling value and decrease in percentage of scrap).

If the component is to be manufactured indefinitely, the value of the extra plant expenditure allowable may be taken at 50d. per component per annum, since the increase of capital to produce 5d. extra dividend would have been 100d. This, therefore, leaves a margin of $2\frac{1}{2}$ per cent, and if the output had been 100 per week only, this would give a safe expenditure of £1,080.

Where a component would last, say, six months only, the balance between the saving and the total output must be reckoned. Following the previous example, under the given output of 100 per week and the saving of 5d. per component, the expenditure thus allowed to improve methods would have been only £54, but since a lower cost of manufacture implies a proportional reduction in the time occupied, a further 5 per cent of the 26 weeks' output value may be added for this, giving a total of £108.

This is the manner in which the plant cost of jigs and tools should be considered, but there is no special machine tool which is likely to be designed for cost reduction purposes (and this is a most important consideration), which would not be easily adaptable to alterations in the design of components. Take the matter of tool expenditure in an even larger aspect. If a car or aeroplane could be produced to sell at £500 by using existing methods, then possibly £550 could be obtained for the better quality that would result if special machine tools were used and interchangeability obtained; and certainly the manufacturing cost could be reduced by £50 at least. This gives a total gain of £100 on every £500, or 20 per cent. If the original capital of the company were £500,000, then they would be quite justified in spending a further 15 per cent of their original capital on special plant to attain this object—in this case, a sum of £75,000. Unfortunately, the plant and engineering side of the question is not the only one to count, as there would have to be a guarantee that the works could be organised to make use of the special machines to the fullest extent.

Jigs for Aero-engine Component.

It is now proposed to give a description of the tools for the small component previously mentioned, Fig. 1. The boring and facing jig is shown in Fig. 2. The machining which will be performed in this tool will be used in locating all the subsequent operations, and is therefore the most important. The work rests on three pegs A, two of which take support under the bolt bosses, and one at the back of the casting. To make certain that the bored hole will be central with the outside, an

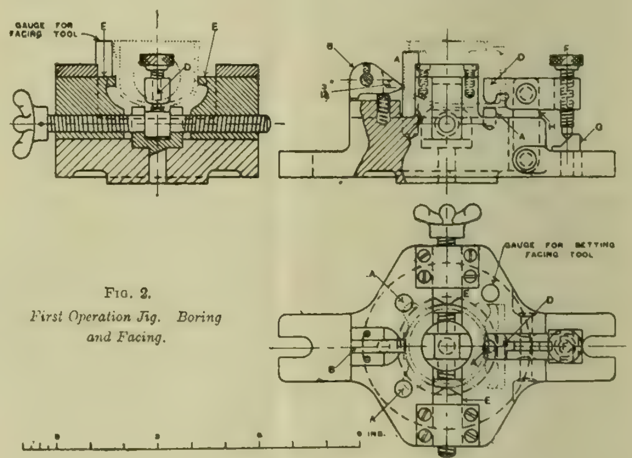


Fig. 2.
First Operation Jig. Boring and Facing.

Jigs, Tools, etc. Fig. 2.

equaliser E is employed, which consists of jaws moved by a right and left-hand screw. These will grip the work and be sufficient to drive the component against the cut. To make certain that the work is set down properly upon the pegs, a special stop B is employed, of which the point of contact is three-sixteenths of an inch below the centre line of its pin, and the more horizontal pressure there is against it, the more the component will be thrust on to the seating pegs. The clamp D fills a double purpose by the action of one set-screw F. When this is turned round, it moves down the taper of the hardened bevel block G, and the clamp being held pivotally upon a link H, it presses both forward and downwards.

With unskilled and female labour it is worth almost any expense in a tool to save the tightening of several screws in setting work. If a job can be put in a jig and all the necessary locations properly seated, and clamping achieved by one action, the tool is quite "fool-proof." To show how multiplicity of clamping operations can be avoided, the next jig, Fig. 3, is more interesting, and although

it is complex, the work cannot be put in wrongly. The piece is located from the previous operation on spigot A, and it is now necessary to face and bore the hole in the top of the component. The jig is practically an angle-plate set positively in two directions, but the component must yet be located in such a way that the machining is square with the general form of the casting. The clamp B with a floating fork C is hinged round the stud D, and clamped by the nut on stud E. On studs D and E is a bevelled recess which slides on longitudinal studs F, and these in turn are bevelled against the equalising studs. When the nut is tightened, the hardened pins slide against one another and the work is equalised and clamped at one operation. When the front face has been bored and machined, the whole fixture is indexed round 180 deg. by means of index pin J, and the back is then faced and drilled without disturbing the component.

Multiple-Operation Machines.

The multiple-operation machine is usually very expensive in first cost. It also requires highly-skilled setting-up, and is often dependent on one

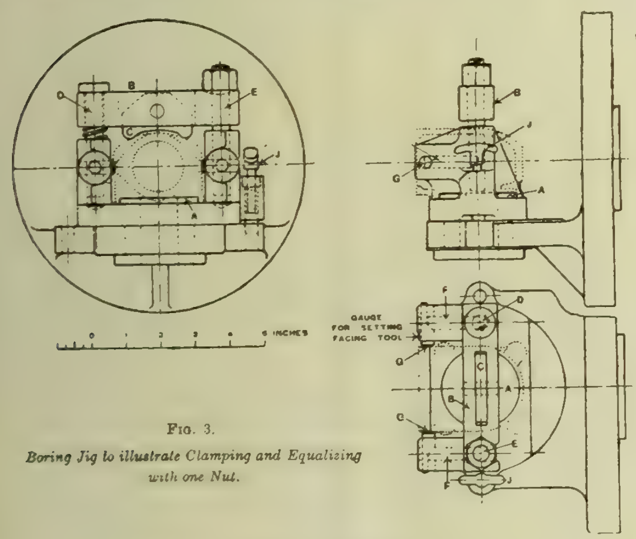


Fig. 3.
Boring Jig to illustrate Clamping and Equalizing with one Nut.

Jigs, Tools, etc.—Fig. 3.

particular man, who has specialised the machine. The cost of the set-up, and the wear and tear of the tools, will be expensive. Multiple operations lengthen out the actual time of handling per piece, and great care and judgment must be given to the chucking of the work. Usually when several operations have to be performed upon a particular component, there is very little space left for gripping, as the area to be tooled is large, and necessitates a very firm grip being taken on a small area, thereby very likely seriously deforming the work. It is sometimes possible to have two multiple machines worked by one operator, and there is a certainty of accuracy between the hole and periphery of the job, which cannot be otherwise guaranteed.

Single-Operation Machines.

The chief advantages appear to lie with the simple machine, that is to say, a machine which does the very minimum amount of work and spends the least time upon the individual component. In a large production there is a great advantage to be obtained by making as many operations, and employing the maximum of machines upon the work as is possible. This practice certainly necessitates extra handling, but the gain in time is enormous. The speed with which a job can be put through is entirely regulated by the length of time of its longest operation. It is a point worthy of note, that in arranging the work for a shop, there is a great disadvantage in basing the production upon the time of the longest operation, compared to basing production on the time occupied by the shortest operation. Taking a week of 50 hours, and a longest operation of 15 minutes, it is obvious that the maximum production of the components will be 200 per week, and limited by this machine, no matter how many other types or quantities of machines there are in the place. Every other machine which is engaged on other operations will have to be idle throughout a large portion of that week, or set up on other work. For instance, an operation which occupies $7\frac{1}{2}$ minutes would have 25 hours unoccupied. The policy of setting up and breaking down machine tools which have been set up for the particular job is not to be recommended, although necessity sometimes forces the practice. On the other hand, consider the production from the time of the shortest operation. Suppose that it is two minutes, then the two-minute machine would be kept fully occupied the whole of the week, and in order to cope with this production of $30 \times 50 = 1,500$ pieces, two machines would be required for an operation which occupied four minutes, and eight machines would be required for an operation which occupied 16 minutes. It is therefore very much to the advantage of the work in every way to be able to work upon the basis of one machine for the shortest operation, and balance up from that; there are then no idle machines. It will be further observed from the foregoing remarks that if the 16-minute operation can be split up into two parts which occupy 10 minutes each, there would be a very decided gain in production, and it would be far more advantageous than installing two machines of the 16-minute operation, because it is reasonable to assume that the 10-minute operation will be only five-eighths as complicated. The simpler and shorter the operation, the cheaper is the labour which can be used, and the machine will require very much less setting up, and very much less skilled attention. Output therefore depends upon the time of the longest operation, and if this can be reduced, there will be an increase of production.

It will be found in the majority of cases that simple operations are very readily adaptable to existing machine-tools and plant, which are often widely different in their original purpose from that required.

In a very large subdivision of operations, consecu-gauging becomes a necessary item, and this should be done immediately after every operation. It is essential that every piece should be gauged as it comes off the machines, even if it has to be moved to a special viewing room, as any error is then found immediately after it is made, before a large amount of scrap work can be produced.

(To be continued.)

Trade Items, Notes, &c.

Edward Hopkinson, Esq., D.Sc., M.P., the President of the Institution of Mechanical Engineers, will give an address at their general meeting, which will be held at the Institution of Civil Engineers, Great George Street, Westminster, at 6 p.m. on Friday, October 24th, 1919.

The General Electric Co. Ltd., 67, Queen Victoria Street, London, E.C.4, have just issued an artistic folder in connection with the reduction in prices of the Atmos type of Osram G.E.C. lamps. A short summary of the manufacture of Osram lamps is given, special reference being made to the Argon producing plant working at the Osram lamp works, Hammersmith, London, which is the first of its kind erected in this country.

World Trade Club starts Metric Campaign.—"Keep the World War Won" is one slogan with which the World Trade Club of San Francisco, U.S., America, consisting of over 500 of San Francisco's leading manufacturing merchants, has started its campaign for the world-wide adoption of the metric units of measurement. Another is: "Our weights and measures made in Germany." The club's arguments show that the weights and measures now used by Britannia and the United States were forced upon England by the German Hanseatic Trading League centuries ago. Germany herself scrapped the old units in 1871, and adopted the metric system, which as originally invented by a Briton, James Watt.

Diesel Engine Users' Association.—At the next meeting of the Diesel Engine Users' Association the subject of the life of connecting rod bolts and their periodical renewal, as well as the general question of heat treatment, is to be further discussed. Information is also to be given as to the proposed Research Association under the Government Scheme for the purpose of carrying out research work on liquid fuels for use in Diesel and semi-Diesel engines. The dinner of the Association, which is to be held on 23rd October, promises to be an interesting function, as it will be attended by several eminent engineers who have taken a prominent part in the developments in Diesel engine practice and fuel oil technology.

Standardisation of Roller Chains.—The Association of British Driving Chain Manufacturers announce that they have now completed the standardisation of roller chains up to ¾ in. pitch. For the convenience of chain users, and to insure complete interchangeability, they have also standardised chain wheel tooth forms. These new tooth forms, while not being identical with any of the existing forms, incorporate the essential features of each. Particulars of the standards set up by the Association of British Driving Chain Manufacturers are to be published in pamphlet form, which will be obtainable from the Secretary of the British Driving Chain Manufacturers, Bassishaw House, Basinghall Street, London, E.C. The Association comprises the following well-known firms: Alfred Appleby Ltd., Birmingham; Brampton Bros. Ltd., Birmingham; "The Coventry" Chain Co., Coventry; Perry and Co. Ltd., Birmingham; and Hans Renold Ltd., Manchester.

The Association of Engineering and Shipbuilding Draughtsmen (Manchester Branch). The above Association will deliver the following series of lectures, which are free to the general public:—

November 13th, 1919, "Ethics of Engineering," J. E. Jolley.

December 4th, 1919, "Design of a 40-ton Titan Crane," P. A. Arbenz and R. W. Mellor; reader, D. Riley.

January 8th, 1920, "The Aeroplane from a Strength Point of View," G. A. Stephens.

January 22nd, 1920, "Steam Raising from Waste Materials," D. Wilson.

February 5th, 1920, "High speed Gearing," M. Coronel.

February 19th, 1920, "Commutators as Structures," R. J. Roberts.

March 4th, 1920, "Screw Propellors," P. Doig.

Copies of the printed papers can be obtained in the lecture hall or from the General Secretary, Mr. P. Doig, 8, Victoria Street, Westminster, S.W. 1. The price of the printed papers is 2s. per copy.

Letters to the Editor.

The Editor will always be pleased to hear from readers who desire to express their opinions upon engineering and kindred subjects. Letters should be as brief as possible and be written upon one side of the paper only. The insertion of a letter in our columns does not necessarily mean that we endorse the opinions expressed therein.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.

To the Editors of "The Industrial Engineer."

Sirs,—I beg to inform you that the inaugural meeting of the session, which was postponed from October 1st owing to the strike, will now be held at the Royal Society of Arts, John Street, Adelphi, W.C.2, on Wednesday, October 22nd, 1919, at 8 p.m., when Mr. Thos. Clarkson will deliver his Presidential address. The Council would like to tender their sincere apologies to those who were put to the inconvenience of endeavouring to attend the meeting on the 1st, owing to the impossibility of giving individual notice of the postponement of the meeting. The meeting of the Midland Centre will be held on Thursday, October 23rd, in the Hall of the Chamber of Commerce, New Street, Birmingham, at 7-30 p.m. Arrangements have been made for a Reception of the members of the Institution by the President and Council at the Kensington Town Hall, on Thursday, November 13th, at 3-30 p.m., when an address of welcome will be given to the members by a distinguished personage. Tea and music will be provided. Further particulars will be issued in due course.—Yours faithfully,

Basil H. Joy, Secretary.

October 8th, 1919.

MR. HARRY GOSLING'S PROPOSALS.

THE NEED FOR A PERMANENT JOINT COUNCIL.

To the Editors of "The Industrial Engineer."

Sirs,—Mr. Gosling's proposals for the establishment of a central executive of labour have aroused considerable attention, but I would like to point out that in the national interest it is essential that both Capital and Labour should be equally well organised. More than that, I would earnestly advocate an extension of Mr. Gosling's idea in the direction of a supreme and permanent joint council of delegated representatives of employers' and workers' organisations, presided over by an impartial and non-political chairman, formed on the lines of the Industrial Council appointed by the Government in 1911. That Council was the first and most efficient organisation ever created with a view to dealing with the industrial position as a whole, as well as with the settlement of industrial grievances, and in the light of what has since occurred, its being allowed to lapse might almost be designated a crime on the part of certain prominent politicians.

Instead of acting upon the information contained in the admirable report (see Blue Book CD 6,952, 1913) which the Council prepared after its exhaustive enquiry, at the request of the Government, into industrial agreements and their observance, and drafting a Bill embodying its recommendations, the Government, with a characteristic lack of foresight, or from some hidden motive, allowed the report to be pigeonholed and the Council to lapse.

If the Industrial Council had been allowed to carry on the work for which it was appointed in 1911, in my opinion the industries of the country could have been efficiently mobilised for war in a very short time, and the industrial unrest which has been so prevalent would have been to a great extent prevented. The Triple Alliance of the miners, railwaymen and transport workers, all of which were included in the original Industrial Council, is not included in the recently appointed so-called National Industrial Council. This suffices to show the utter hopelessness of that body being able to deal efficiently with the present industrial position.

As an indication of the value of the work and influence of the Labour representatives who served on the original Industrial Council, I have only to recall the all-important part played by some of them in connection with the settlement of the recent railway strike, which I see is estimated to have involved the loss of £50,000,000. I am, yours faithfully,

Charles W. Macara.

York Street, Manchester,
October 11th, 1919.

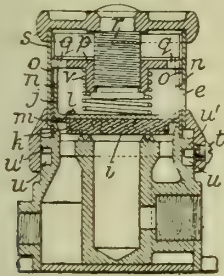
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

VALVES.

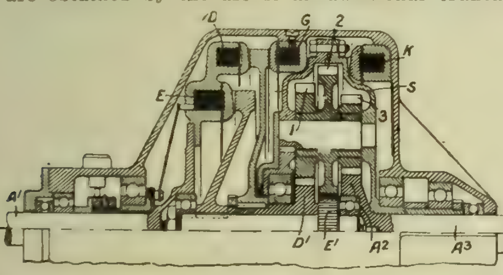
121,570.—J. H. GAYMER, 64, Sheringham Avenue, Manor Park, London.—June 15th, 1918.—A relief valve of the kind described in Specification 109,526, in which the valve member is mounted on a piston sliding in a cylinder arranged on the outlet side of the valve, has the outlet apertures formed in the bottom of the cylinder, and has the loading spring adjusted by a nut slidably mounted in the cylinder and engaged by a screw carried by a cap rotatably mounted on the cylinder. The valve member *i* is secured



to the piston *j* by a metal frame *k* having a flange *m* adapted to be held against the piston by lugs *l* passed through slots in the piston and then bent over. The cylinder *e* has slots *o* adapted to be engaged by projections *n* on the piston and by lugs *q* on a nut *p* bearing against the loading spring *v*. The nut *v* is reciprocated by a screw *r* carried by a cap *s* adapted to rotate on the cylinder. The lower end of the cap is fitted with pins *t* adapted to engage, under the influence of the loading spring, one or other of notches *u*1 formed along the upper surface of a groove *u* in the valve body, to lock the adjustment against accidental movement.

VARIABLE-SPEED EPICYCLIC GEARING.

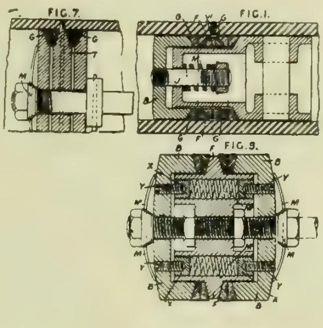
121,616.—WOLSELEY MOTORS LTD., and E. REEVE. Adderley Park, Birmingham.—October 25th, 1917.—In spur-wheel epicyclic variable-speed and reversing gearing of the type employing electro-magnetic clutches and brakes, two driving sun wheels may alternatively or simultaneously be clutched to the driving shaft a larger sun wheel forms the driven element, and brakes may be applied to the larger of the driving sun wheels and to the planet carrier. In a modification, two additional forward or reverse speeds are obtained by the use of an additional brakeable sun



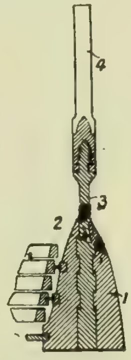
wheel and a corresponding planet wheel. Sun wheels D1, E1 may be clutched to the driving shaft A1 by electro-magnetic clutches D, E. A large sun wheel A2 is secured to the driven shaft A3. Brakes G, K are provided for the larger driving sun wheel D1 and the casing S carrying the connected planet wheels 1, 2, 3. First and second speeds are obtained by driving wheels E1 and D1 separately and exciting the brake K. Exciting both clutches D, E gives solid drive, and driving the wheel E1 and exciting brake G gives a reverse. In a modification, a fourth sun wheel provided with a brake gears with a fourth planet wheel and provides two additional speeds according to which sun wheel is driven, the direction of drive depending on the proportions of the gearing. The casing S retains lubricant.

PISTONS; STUFFING-BOXES.

121,632.—J. A. SPENCER, of Spencer and Sons, Scott's Road, Southall, Middlesex.—December 20th, 1917.—Packing for the pistons of internal-combustion engines, steam engines, pumps, compressors, valves, etc., consists of split bevelled rings compressed by bevelled collars, heads, or plates which are acted on by springs, by the fluid pressure, or by both. Fig. 1 shows a piston for an internal-combustion engine in which split bevelled rings G are compressed by a loose head B which is acted on by the fluid pressure and by a spring M on a bolt J. Relative movement of the rings G is prevented by screws inserted between them. A central split ring F is made with clearance from the cylinder and is supplied with lubricant, either at the back or from a passage Y1 in the cylinder wall. The rings G are formed also with lubricating grooves. In a modification, the packing is compressed by a loose collar acted on by springs interposed between the collar and a junk plate. The latter is perforated to permit access of the fluid pressure to the loose collar. Fig. 7 shows a steam-engine piston built up of plates T with interposed bevelled packing G. One plate may be keyed to the rod, while the others are loose and are acted on by blade springs M. Fig. 9 shows a piston for an internal-combustion engine in which the packing is compressed between a central flange F on the body and end plates B which are acted on by the fluid pressure and by blade springs M. The force of the explosion is cushioned by springs M1 acting on plungers X mounted on screws Y carried by the heads B. In a modification, the heads B are bolted to the piston body, and the packing is compressed by loose collars acted on by springs and by the fluid pressure admitted through perforations in the heads B.



Patent 121,632.



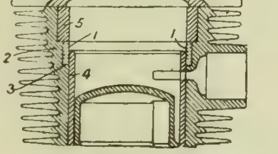
Patent 121,692.

TURBINES.

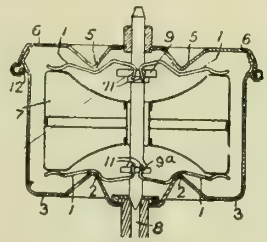
121,692.—BRUSH ELECTRICAL ENGINEERING CO., 11, Arundel Street, Strand, London.—(Aktiebolaget Ljungströms Angturbin, 2, Arsenalsgatan, Stockholm.)—May 8th, 1918.—A turbine disc 3 carrying blades 4 is strengthened by two side discs 1, 2 rigidly secured thereto by a series of flanges and dovetailed grooves 5, the side discs being shrunk on to the central disc.

INTERNAL-COMBUSTION ENGINES.

121,673.—T. A. N. LEADBETTER, Arcan, Bower Road, Hale, Cheshire, A. L. KNOX-GILCHRIST, 50, East Beach, Lytham, Lancaster, and W. H. TATE, 7, Westbourne Grove, Barkers' Lane, Ashton-on-Mersey, Manchester.—February 26th, 1918.—In an engine having a reciprocating sleeve valve 4, an inwardly contractible packing ring 1 is provided seated either in a recess 3 in the cylinder wall 2 and retained by a bush 5 or in the outer surface of the sleeve valve. In the latter case, which is particularly advantageous where the cylinder is of aluminium, the ring or rings bear against a bush having ports coinciding with those in the cylinder wall.



Patent 121,673.



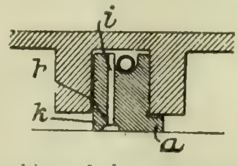
Patent 121,747.

INTERNAL-COMBUSTION ENGINES.

121,747.—J. T. JENNINGS, 35, Wharf Road, King's Norton, Birmingham.—May 26th, 1916.—The float valve of a carburettor is actuated positively both by the rise and fall of the float by providing a pair of actuating levers above and below the float. The float 7 actuates the valve 8 through two pairs of levers 1, the fulcra of which are formed by annular V-shaped projections 2, 5 in the base 3 and cover 6 respectively. The levers are preferably formed of hard sheet brass so as to be resilient, and the bent ends 11 of the upper pair thereof engage slots in a collar 9, whilst the lower pair engage a plain disc 9*a* on the valve spindle, the upper collar being preferably loose. The cover 6 is secured by a spring ring 12.

PACKING FOR ROTATING SHAFTS.

121,718.—SIR C. A. PARSONS, S. S. COOK, and L. M. DOUGLAS, Heaton Works, Newcastle-on-Tyne.—November 19th, 1917.—In

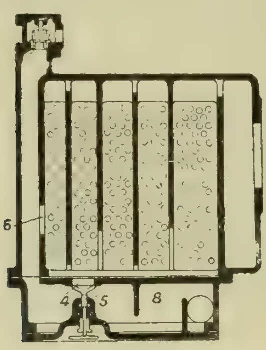


segmental carbon packing of the type described in Specification 121,622 having a flange *a* exposed to the lower pressure, tilting

of the packing is prevented by steam admitted to a groove h by axial grooves k. The steam passes to the back of the ring by ducts i.

STEAM-CONDENSERS.

121,775.—D. B. MORISON, Hartlepool Engine Works, Hartlepool, Durham.—December 13th, 1917.—Surface condensers are provided with a restricted opening 4 for the escape of condensate so that, above any predetermined steam load, condensate collects in the condenser and is cooled by contact with the condensing surface, variations in the steam load being thus automatically accompanied by variations in the amount of immersed condensing surface. The steam load at which cooling of condensate begins is determined by setting a valve 5 controlling the effective area of the opening 4. The maximum depth of immersion is determined by an overflow 6. The condensate from the openings 4, 6 flows to the hot-well 8. In the multi-compartment condenser shown, the flooding of the base of the condenser simultaneously produces a more uniform distribution of the steam.



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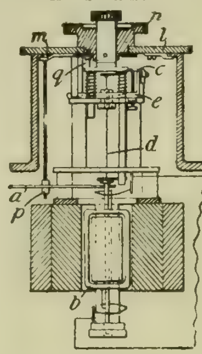


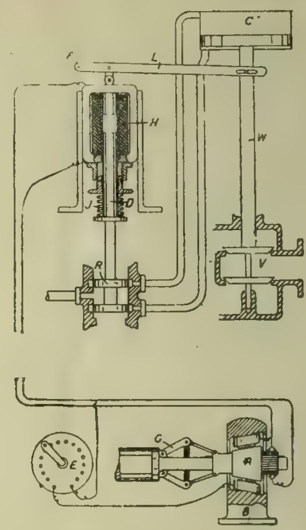
Patent 121,830.

ELECTRIC METERS; PYROMETERS.

121,830.—CAMBRIDGE SCIENTIFIC INSTRUMENT CO., Cambridge, and E. C. HURST, 96, Huntingdon Road, Cambridge.—Jan. 10th, 1918.—In a moving coil instrument, means are provided for adjusting the torsion of the suspension or spring to a predetermined value, and in instruments for use in pyrometry, means also are provided for compensating for variations of the temperature of the "cold junction." As shown, the coil b is suspended by a thread d from a spring c carried by a pivoted arm e. In setting up the instrument, the coil is first turned by means of a head n with an arm m and stop p acting on the pointer a so as to move this from the zero position to a predetermined mark along the scale. The suspension, the head n, and stop p are then turned backwards together by means of a cover plate l with a fork q engaging the arm e until the pointer is returned to the zero position, or in the case of pyrometry, to a mark on an auxiliary scale corresponding to "cold junction" temperature.

SPEED GOVERNORS.

121,768.—J. T. MILLER, The Residence, Trafford Park, Manchester.—November 24th, 1917.—Apparatus for controlling the speed of turbines, etc., comprises a fluid-pressure servo-motor C, the valve R of which is controlled by a solenoid H. The solenoid current is controlled by a governor G driven by the turbine, and is supplied by a generator B, the pole bore and armature A of which are of conical shape so that the armature may be moved by the governor G to vary the air gap and thus vary the current.



The solenoid is connected to the rod W of the valve V by a link L pivoted at F, so that the movement of the valve V restores the valve R to normal position. In another form the solenoid is fixed and the plunger D is connected to one end of a link L, which is connected at the other end to the rod W and at an intermediate point is pivoted to the valve R. The normal speed of the turbine may be varied by means of a rheostat E in the field circuit of the generator or by adjusting a spring J controlling the plunger D. The poles of the generator may be mounted on a slide so as to be adjustable axially by hand to vary the air gap.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

MECHANICAL TRANSPORT.

THE most revolutionary discovery man ever made was the wheel; not very far behind, if indeed it is not quite as revolutionary, was the application of power to transport. The full virtue of the wheel only became obvious when it was used as a means of propulsion itself; this alone changed the world's history, and we are only yet at the beginning of mechanical transport when men begin to use the sky for a roadway. It will, however, be many decades yet, if ever, before the general transit of goods is by airway. Nor is it likely that the railroad, whatever the power used may be, will ever be superseded. There are, of course, idealists who predict universal flying as the one means of transport, but very practical considerations limit the newest servant of man's desire.

It was the economist who drew general attention to the vital function of transport to the community at large. Civilisation, as commonly understood, is dependent upon means of transport; the more highly civilised the country the greater the facilities for people and for goods. Transport, in terms of time, determines the distribution of the population; in terms of goods, it determines price and sustenance. Hence the paramount value of all descriptions and types of conveyance. The complexity of the subject lends it a fascination, and its importance is at least equal to that of more debated themes. Those who see the romance hidden in the prosaic must be struck with the vast effort and ingenuity which have made the question one of enthralling interest, for transport has remodelled the world anew. In all elements man now takes his way, and the supreme inventions have mainly had transport as an end. Distance has been robbed of its terrors, and latterly, at all events, man has become three-dimensional in his progress; even the critic who will allow little merit to modern civilisation has to admit the value of transit. He may ask the questions, usual in such connections, as to the merit of the cinema, the phonograph, the telephone, query whether the hurry and bustle of modern existence is justified, but he has to admit that life is simplified and he is fed, because of transport. The shorter hours in industry are going to have their own reaction in decentralising population; with a shorter day greater distance becomes possible, and it will not be the wealthy alone who will seek the seclusion of the distant country-side for residence. One of the greatest disabilities of the war period was restriction of movement due to national necessity; and until this is removed in process of time, most of the schemes for better conditions of life must remain unaccomplished. We are at present suffering from congestion of traffic, and its results are to be seen in part in localised high prices; railways are choked with traffic, docks are congested with goods, steamers are held up, and everyone suffers for the disorganisation.

All the means of transit are parts of one coordinated whole, and until the separate factors again work in unison, so long as disorganisation persists, normal conditions cannot return. The ship which thrashes her way with food for a whole city has to wait a berth to discharge; meanwhile, the profiteer fattens on the daily necessities of the inhabitants, while if given free interplay, prices fall. The more the matter is examined, the closer the scrutiny, the greater this question of transport becomes.

The grimy hand of the engineer is in it all from start to finish; whether it be ship, railroad, or road traffic, mechanical art is supreme; every shuttle by

which civilisation is woven bears his imprint; over all is written mechanism. Nearly every modern problem of practical type requires engineering art for its solution; even present troubles can be solved only by more adequate means of conveyance involving more mechanism.

Meanwhile, transit interests quarrel among themselves, and petty local authorities can exercise a veto at their own sweet will, irrespective of the convenience of the community; such archaic survivals have outlived their day of grace, and a different system is overdue.

Intensification of mechanical means truly co-ordinated seems simple sanity; animal traffic cannot survive save where, by reason of local conditions, mechanical transport finds insufficient employment, or the community is of backward type. As an addition to all his other services, the engineer has done the most to render cruelty to the dumb creation impossible. Intimately bound up with the subject is the question of road surface. Recently, a Canadian engineer, treated an audience to a dithyrambic on the subject of the patron saint of road makers, Macadam. Well, it is a good theme, but the road and the vehicle cannot be separated; the one exists for the other. It is a thousand pities that to forestall a competitor the railways were allowed to obtain control over inland waterways; the internal combustion engine makes possible cheap mechanical transport waterborne. Under rational management the one method is a complement of the other, not a rival means of conveyance; coal and pig-iron, sand and cement, bricks and similar goods would appear better moved by barge than by rail. To convey articles like these expensively and quickly seems folly if it can be arranged otherwise; railing coal, for one example, from the north to the south of England is wastage of national resources, as it can so much more cheaply be seaborne. Questions like these call for solution, and the new Ministry of Transport may find a fertile field if they will tackle the problem in the right way, and it will be real conservation of resources adding to general well-being, for, after all, directly or indirectly, all are taxed by the present want of system. Public utility monopolies must serve public needs, and the sooner this is realised the better.

Transport taxes all production; takes a toll from all. We are to-day suffering from the sins of our ancestors, but that is no reason why matters cannot be amended for the better; the time has come when full consideration must be given to the subject, and money spent on roads, for one example, is real productive outlay. The larger question of properly unified transport will have to be faced sooner or later; nationalisation seems unlikely for many reasons, but co-ordination seems imperative. Much more could be done by arrangement and understanding between the interests involved, who could thus forestall political action if conditions become intolerable. There is a spirit abroad which can be laid by measures of common sense, but which if affronted by continuance in folly will make national action inevitable.

Those who see farthest realise that service to the community at large is, or should be, the outstanding feature of public utilities; without this the nation is penalised. It is overlooked by the antagonistic elements in industry and in transport; the national estate is far too precious to jeopardise by any single interest. There is much to be grateful for in individualistic enterprise, but it needs a measure of control to ensure general well-being, and the new Ministry has apparently been created with this in view. Provided always it does not strangle legitimate enterprise, it should serve a useful purpose.

It is usual to confine the term mechanical transport to motor road vehicles, but in reality it includes all transport using motive power, and no broad consideration of the subject is complete which does not take into notice railway, tramcar, lorry, and pleasure car. The subject is vast, the possibilities endless; while the aeroplane, as the newest triumph of mechanical art, deserves, as it has already obtained, extended notice in many quarters. Eventually it may displace a proportion of its slower rivals, but its extended use as a means of goods transport is certainly a long way off.

VANADIUM BRONZE.

A STRIKING COMPARISON.

(With Topical Criticism.)

Written and Illustrated by James Scott.

On March 25th, 1919, the Institute of Metals held one of its periodical meetings, to which I was invited but was unable to attend. As, however, the many useful addresses given before that concourse of scientists are usually published broadcast, the general facts to which considerable expert attention is given eventually become public property and are, therefore, responsible for great advances in special knowledge, and consequently benefit industry itself.

Among the papers read was one by Lieut.-Colonel C. F. Jenkins, R.A.F., M.A., M.B.E., on "Metallurgical information required by engineers." Some of the very sensible statements then made deserve to be specifically mentioned in these pages, and may legitimately lead up to the publication of my own notes and original illustrations upon the subject named in the heading of this article.

The speaker was responsible during four years of the war period for recommending materials designed for use in aero-engines and aeroplanes, so that his present conclusions are not without appropriate importance. He pointed out that in engineering circles the two main properties or qualities required in any substance were stability (*i.e.*, strength to resist deformation), and long life (*i.e.*, endurance under stresses, abrasion, and corrosive agencies).

The truth that the metallurgist's and engineer's points of view were remarkably at variance was emphasised; yet the work and study of the first are intended to be industrially applied by the second. Therefore, what was the use of referring, in connection with metals, to chemical analysis, microstructure, tenacity, elongation, thermal analysis, elastic limit, scleroscopic, etc., hardness, fatigue range, reduction in area, bend and torsion tests, and so on? Such phrases are understood among fellow metallurgists, and possess profound significance; but in a specification to be laid before an engineer they are mostly devoid of meaning.

The lecturer said, in reference to the want of understanding between metallurgists and engineers: "In an attempt to bridge the gap between the two

we use a terrible list of vague words to hide our ignorance." He then named the terms that I have previously written down.

Referring to certain metallurgical tests he said: "These apparently important mechanical tests are really no more rational guides than, say, colour.

"If the metallurgist's properties are so useless to the engineer, why are so many of them included in the specification? Owing to the lack of knowledge about the life and stability of materials, it is not possible to specify such qualities. . . .

"A satisfactory answer to the problem should not be beyond the reach of the metallurgist and the engineer if they work in conjunction.

"Too many new tests have been devised in recent years without any exact knowledge of what their results signify."

There is no need to quote any more. My object is to show that the metallurgist cannot be relied upon to guide the engineer in respect of the capacities of a metal merely by means of abstruse particulars. Microscopical comparisons, however, in conjunction with the ordinary power of judgment gained by experience, will often be more effective in this direction than a whole lot of technical jargon. Take, for instance, the new bronze herewith illustrated. It is applicable to all cases in which the commoner run of bronzes are used, and these do not require citing just now. But is is superior in many ways to others of the group, owing to its hardness *minus* brittleness, resistance to frictional and corrosive influences, and so on.

Two three-quarter inch sample rods of this bronze were specially supplied to me by the Yorkshire Engineering Supplies Ltd., (abbreviated in trade circles as Y.E.S.), Upper Wortley Road, Wortley, Leeds. One of them has been cast in sand in the usual manner, and the other has been cast in water-cooled moulds by the firm's famous "Eatonia" process. If contrasts in structure possess any value, as they undoubtedly must do, then it is an easy matter to learn which of the two should prove the best in mechanical work. The composition of this bronze is copper 88 per cent, lead 1 per cent, phosphor tin about $10\frac{1}{4}$ per cent, and cupro-vanadium about $\frac{3}{4}$ per cent. Copper and lead are too well known to need further reference. Phosphor-tin is a compound of that metal with a small quantity of phosphorus, which serves both to eliminate obnoxious gases from the alloy and to confer strength upon it. Cupro-vanadium is a compound of copper and vanadium, and has been found to be the best medium for the introduction of vanadium into the remaining mass of metal.

Vanadium was discovered as recently as 1801. When completely isolated from other metals it occurs as a grey crystalline powder, very infusible, and immune to chemical attacks which readily destroy the commoner metals. These traits it imparts in a large degree to the alloys containing it. For example, it makes steel almost unwearable, however severely it is worked.

I do not propose to go at all deeply into the mysteries of fusion formation of this alloy; but it is necessary to state that when two or more metals are melted together the result is generally one of the three following:—

The metals in cooling, crystallize separately as minute particles intermixed with one another.

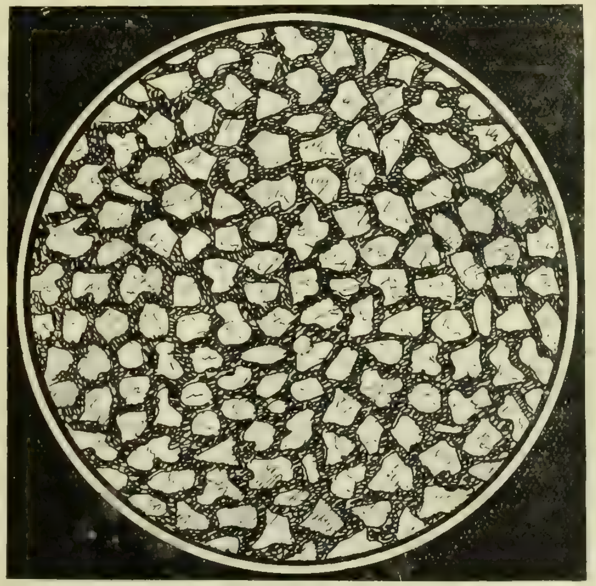
The metals chemically combine to yield an entirely new substance or compound, quite unlike either of the component elements.

The metals produce a mixture of both the preceding, aggregates of one kind being locked up between others.

There are many modifications; but the above are the broad outlines.

Even with alloys of two metals (binary ones), and of three metals (ternary ones), we have much more to discover before it is possible to become positive in several of our investigations. Hence, the still less studied alloys of four metals (quaternary ones), to which vanadium bronze belongs, offer a wide field for new research.

Doctors M. and C. Giua, in their remarkable volume on "Chemical combinations among metals," published in 1918, say on page 2, in refernce to the ordinary metallurgical summaries: "This classification has a purely systematic value, because in reality there are cases in which the components form solid solutions to a limited extent, and in which,



No. 1.—One-twenty-fourthi'nch of the smooth surface of Vanadium bronze, cast by the "Eatonia" chill process; magnified. The minute grains are uniform, even, and intact.

while chemical combinations occur, polymorphic (changes in crystallization) transformations exist with more or less extended series of mixed crystals, and partial lack of miscibility."

In plain language, this means that a metallurgist may make claims which are absolutely wrong.

Again, on page 99, they say: "Comparatively few intermediate compounds, *i.e.*, alloys, have been studied crystallographically; so that we possess very little definite information on this subject." Remarking on certain tests they say on page 37: "Here our knowledge is indeed faulty."

I could quote many other statements from these authors, and from a lot of independent sources—all the opinions of experts—in the same strain; proving essentially that the engineer is not helped as he should be, and often mistakenly believes he is, in the matter of appreciating the value of an alloy from the expressions of the metallurgists, but I will refrain.

Now I will deal more closely with the selected material. Chemical analysis and micro-structure (which I here give), and mechanical tests which he can himself apply, give the engineer an almost sufficient clue to the value of an alloy, provided he can compare the data with previously used material of the same, or similar, nature.

When an alloy is cooling and hardening from the molten state, it does so by the formation of minute crystalline grains. Such crystallization may continue during the use of a substance, and set up innumerable defects, and it is for this reason that skilful after-treatment has often to be resorted to. But it is preferable, if possible, to prevent this tendency to prolonged crystallization, and one way to do this is to cause the molten mass to solidify with the utmost rapidity, as in the case of the special process now under consideration. After-treatment of a good thing will plainly be an improvement upon after-treatment of a bad one.

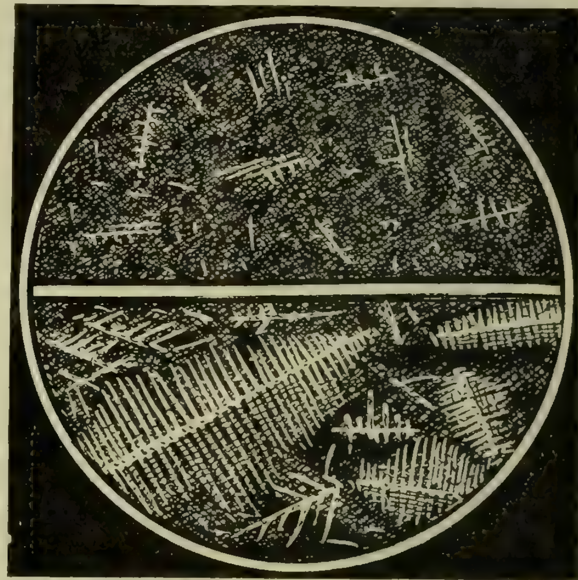
It is obvious that if a composition and structure are extremely excellent—as vanadium bronze is—a better grade of the same substance will give additional advantages.

A reference to the illustrations should be convincing on this point. Typical portions of both sand cast and "Eatonia" cast alloys are represented. In No. 1 is shown an area of the clear yellow, even surface of "Eatonia" cast vanadium bronze, disclosing its very minute crystallization, and in No. 2 is shown a similar part of sand cast vanadium bronze, disclosing its very coarse crystallization, and vari-coloured broken grains.

Additional confirmation of merit can be secured by filing and breaking the rods, and examining the

No. 2. One twenty-fourth inch of the smooth surface of Vanadium bronze, cast by the ordinary sand process; magnified. The minute grains are irregular, coarse, and broken.

fractures which are compared (on a smaller scale of magnification) together in No. 3. Owing to compression, and opportunities afforded thereby, the inner crystals are better fused mutually, and lose sharpness of boundaries; and at the same time more regular, larger figures, crystalline in character, are enabled to form, by means of superimposed laminæ, which are revealed in cross section as rows of edges. Now the figures of the sand cast vanadium bronze are much larger, and less homogeneous than those of "Eatonia" cast vanadium bronze. In the first case, too, segregation—or irregular collection of



No. 3.—One quarter inch areas (in the widest parts) of the fractures of Vanadium bronze, cast by the "Eatonia" process (above), and by the sand process (below); magnified.

crystals—is possible, through the longer time allowed in cooling, whereas it cannot happen in the second case, as solidification is too prompt.

To finish my notes, it is only necessary to say that, of two excellent grades of bronze, one, the water-chilled specimen, must be superior to the other. No fantastic terms will alter that fact.

REPORT ON THE EXPERIMENTAL USE OF POWDERED FUEL FOR PUDDLING FURNACES.*

Before deciding to incur the large expenditure involved in adopting a powdered-fuel plant for the forge, it was arranged, in view of the many factors that enter into the question, to make an experiment at one of the puddling furnaces of the Shelton Iron, Steel, and Coal Co. Ltd., and a plant was ordered in this country for the purpose, the powdered fuel for the test being specially obtained from a crushing plant usually used for cement.

The fineness of the coal dust was all that could be desired, but owing to the dust having to be brought a considerable distance on the railway, a quantity of moisture was absorbed, and the powdered fuel therefore contained more than is desirable and more than would be obtained if a complete plant were put down at the forge. The moisture in the fuel used for the experiment varied from $1\frac{1}{2}$ to $2\frac{1}{2}$ per cent, but there would be no difficulty in getting it down to 1 per cent.

* Paper read by W. Simons (Stoke-on-Trent) at the Autumn Meeting of the Iron and Steel Institute, September, 1919.

Heating Up.

No difficulty was experienced in getting the requisite temperature. The time taken for heating the furnace from cold did not take more than one and a half hours, as compared with three to four hours required for ordinary firing.

Wear in Brickwork.

With the first position in which the burner was fixed the flame caught the roof of the combustion chamber, causing rapid wear of the brickwork. The position of the burner was altered, and at present comparatively little wear is taking place, but there is no doubt that further improvements can be made in the combustion chamber and in the form of the furnace to adapt it to this system.

Fuel Consumption.

This works out at about 30 per cent better than the usual consumption of fuel per ton of iron made. Further economies can be made with the experimental plant, and with the greater range of regulation that would be provided in a complete plant still further reductions in fuel consumption could undoubtedly be effected.

Waste Heat.

A meter was fixed to the feed-water pipe of the boiler and the evaporation of the boiler was reduced by 10 per cent for 30 per cent reduction in fuel, but with the increased output that could be obtained by the use of powdered fuel there should be no reduction in the total evaporation of the boiler previously obtained.

Output.

There can be no doubt that greater output can be obtained with powdered fuel owing to the complete combustion of the fuel. The under hand is relieved of the work of firing, and is set free to assist the first hand. Heats were worked in $1\frac{1}{2}$ hours, and in one case 1 hour 20 minutes, and the furnace was held back to some extent by having to take its turn with other coal-fired furnaces.

General.

The result of the experiment leaves no doubt that there is a great advantage in using powdered fuel for firing puddling furnaces. Greater output can be obtained, and economy of at least 30 per cent should be obtained in the fuel used.

The men who have worked the furnace appear to be pleased with the result, and are anxious to know whether it is intended to put down a complete plant.

On the basis of 30 per cent fuel economy, and taking the cost of a plant for about ten puddling furnaces and firing two Lancashire boilers (which are adjacent to the forge) as being £22,000, and allowing 2s. 9d. per ton on fuel for grinding, but without allowing for interest and depreciation, there is a net saving per annum of 23 per cent on the capital outlay.

In view of the importance of fuel economy, the result of this experiment may prove of interest.

SIR HENRY ALEXANDER MIERS, D.Sc., F.R.S., Vice Chancellor of the University of Manchester, has been appointed by an Order of Council dated the 16th day of October, 1919, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

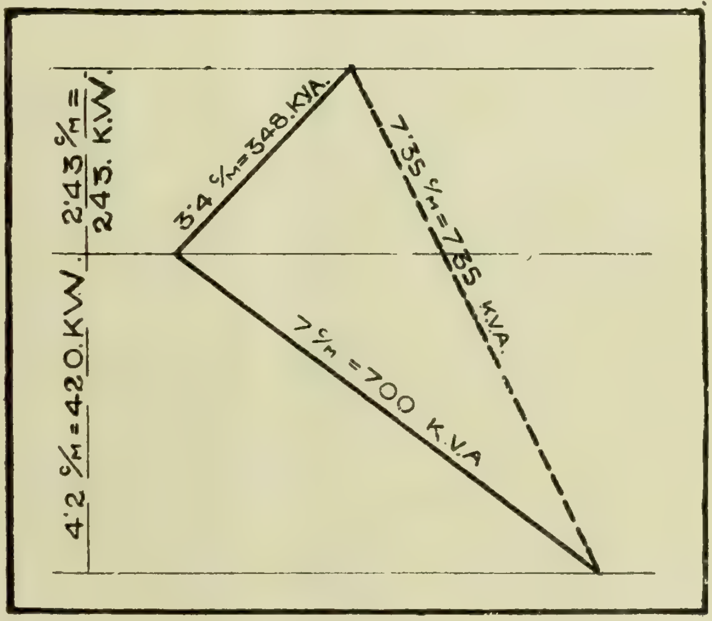
POWER FACTORS.

By F. ASHTON.

(*Continued from page* 10.)

Improving the Power Factor.

The problem of raising the power factor of an alternating-current plant is an important one, and one with which many engineers have had to grapple. Several methods may be adopted, but the fundamental principle is the same in each case. What is necessary is, of course, to eliminate the wattless current, circulating between the load and the generator, and anything that draws a leading current will produce this effect. If, for instance, an over-excited synchronous motor, or an electro-static condenser be connected near the load that causes the low-power factor, then the wattless current can be made to circulate between the load and synchronous motor or condenser, instead of between the load and alternator. In this way the mains and



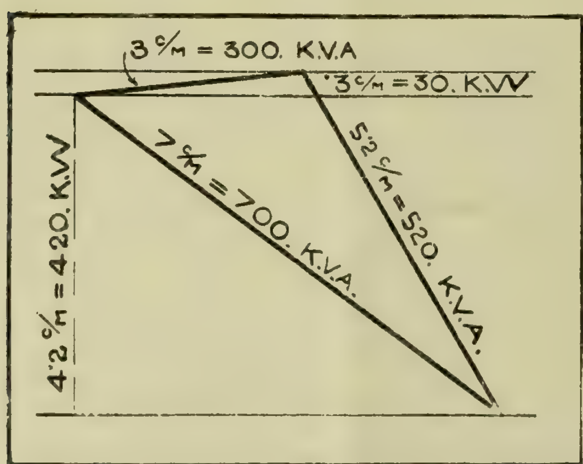
POWER FACTORS.—FIG. 4.

generator windings are relieved of the idle currents they would otherwise have to carry. In many cases synchronous motors have been installed entirely with a view to raising the power factor; but it is much better, if possible, to make the motor perform mechanical work as well, for the capital cost of the machine is then only partly debited against power-factor correction. Why is it that an over-excited synchronous motor drawing a leading current need not be considered. It will suffice to say that the power factor of a synchronous motor is dependent upon the exciting current. One particular exciting current brings the main current exactly into phase with the supply pressure, but if this exciting current be decreased the main current lags with respect to the pressure, whereas if the exciting current be raised above the value which gives unity power factor, the main current leads with respect to the pressure. If this leading current is made

equal to the lagging component of the load, then the power factor will be raised to unity. The motor is simply connected across the mains in the vicinity of the load that gives rise to the low-power factor, so that instead of the wattless current circulating between the load and generator, it circulates between the load and over-excited synchronous motor. It is not usual to endeavour to bring the power factor absolutely to unity, for the expense involved does not, as a rule, warrant it, a power factor of about .9 being quite good enough for all practical purposes. Suppose, by way of example, that the load is 420 kilowatts, and that the power factor is .6, then the kilovolt amperes are $\frac{420}{\cdot 6} = 700$. Suppose now that a 300 H.P. synchronous motor is installed near the load, and that the excitation is adjusted so that the machine works with a leading power factor of .7, the efficiency of the motor being 92 per cent. The kilowatt input of the motor will be $\frac{300 \times 746}{\cdot 92} = 243$

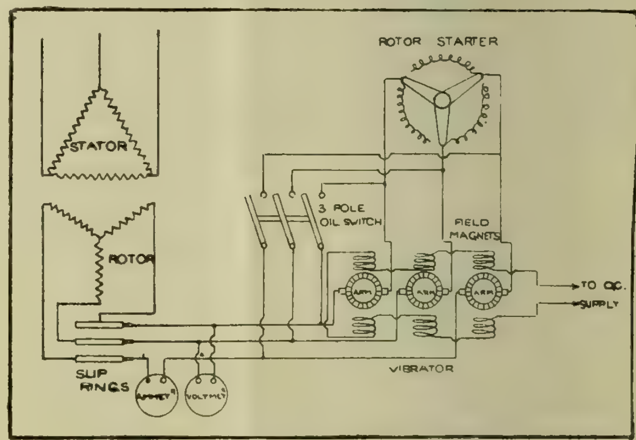
and the kilovolt amperes $\frac{243}{\cdot 7} = 348$.

In Fig. 4 the kilowatts are set off on the vertical line to a scale of one centimetre for every 100 kilowatts, the 420 kilowatts being due to the main load, and the 243 kilowatts to the motor. Between the vertical lines representing these loads a horizontal line is drawn, and also a horizontal line at the top and bottom extremities. Adopting the same scale



Power Factors.—Fig. 5.

as before (*i.e.*, one centimetre per 100 kilovolt amperes), a diagram may be drawn between the horizontal lines in the manner shown, the slanting line between the middle horizontal line representing the 700 kilovolt amperes, and the slanting line above the middle horizontal line the 348 kilovolt amperes. The dotted line represents the total load, *i.e.*, 735 kilovolt amperes. The total kilowatts are now $420 + 243 = 663$, and the power factor of the circuit is therefore raised to $\frac{663}{735} = \cdot 9$ This is an example of a synchronous motor being used for developing mechanical power and raising the power factor at the same time, but when there is no demand for mechanical power it may be necessary to run a motor light, so that it only deals with the wattless load necessary for power factor correction. In this case the line representing the motor input will be nearly horizontal, as shown in Fig. 5, for the actual power consumed by the motor is only that which goes to make up the losses. Taking the main load to be 420 kilowatts, and the power factor to be .6, as before, and assuming that a 300 horse-power



Power Factors.—Fig. 6.

synchronous motor is connected to the mains and loaded with wattless current, a diagram such as that shown in Fig. 5 may be drawn, where it is assumed that the motor losses amount to 30 kilowatts. The total load in this case is $420 + 30 = 450$ kilowatts, whilst the total kilovolt amperes, as obtained from the diagram, amount to 520, so that the power factor is $\frac{450}{520} = .86$. In this case the kilovolt amperes are reduced by 25.5 per cent.

Special Synchronous Motors for Power Factor Correction.

The use of a synchronous motor affords a ready means of correcting the power factor, especially if the motor also performs mechanical work. At one time the main objection to the use of these motors was the difficulty in starting them, for synchronous motors, as ordinarily built, must be run up to speed and synchronised before they can be connected to the mains But this difficulty has been eliminated by the introduction of self-synchronising machines, as built, for instance, by the Lancashire Dynamo and Motor Co. and the British Westinghouse Co. Such motors can be started with practically the same ease as ordinary induction motors. As a matter of fact, these so-called self-synchronising or induction synchronous motors are started as induction machines, and the rotor is excited with direct current after speed has been attained. The motor then becomes a synchronous machine capable of raising the power factor. Another method of raising the power factor of a system is to provide one or more large induction motors with phase advancers. A phase advancer is a small alternating-current exciter, which is connected to the slip rings of large induction motors,

and supplies the rotor winding with a leading current, the effect being to reduce the magnetising current supplied to the stator of the motor. With these phase advancers induction motors can be made to work at unity power factor, or, if necessary, they can draw a leading current which will compensate lagging currents in the same way as our excited synchronous motors. Phase advancers have not, however, achieved the popularity that some engineers anticipated. Some phase advancers resemble in appearance an ordinary direct-current exciter, and are either directly coupled to the machines they excite or are driven by independent motors. A totally different type of phase advancer is made by the Sandycroft Foundry Company, and a diagram of the connections for this machine is shown in Fig. 6. The phase advancer in this case is composed of three small armatures capable of oscillating between the poles of direct-current field magnets. The brushes of each armature belonging to the phase advancer are connected up to the slip-rings of the induction motor in the manner shown. When the three-pole oil switch is closed, after the motor has been started, the three direct-current armatures are in series with the rotor windings of the induction motor, and consequently the armature windings are traversed by alternating currents of low frequency. The field magnets of the phase advancer are excited with direct current, and the low-frequency currents in the armatures cause the latter to oscillate backwards and forwards. This causes the armatures to generate voltages leading on the rotor voltages, and the induction motor is therefore supplied with leading current, which raises the power factor. The voltages produced by the phase advancer have crest value at the time the current passes through its zero value, and zero value when the armatures reverse—in other words, when the current has crest value. In this way, a quadrature phase relationship is brought about between the current, causing the armature to vibrate, and the electromotive force produced by the vibration.

(*To be continued.*)

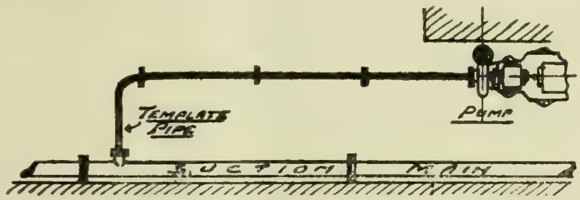
ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

(*Continued from page 25.*)

The draughtsman should select for his template pipes those that will allow for differences two ways if possible, instead of two make ups. Fig. 85 will make this clear.

All pipes must be numbered by the draughtsman both on the detail and general arrangement drawings. This saves the erector time in trying to find the various pipes as they get delivered, and thrown about all over the site. They should have the item numbers clearly painted in two places on each pipe, a note being put



Engineering Lay-out.—Fig. 85.

to this effect on the detail drawing by the draughtsman when ordering same. This is only a little point, but saves untold worry, and often strong language, when the pipes are wanted; it also facilitates a ready check being made on the pipes as delivered.

On the detail drawing of the pipes the draughtsman should clearly state in the form of a neatly-worded note the following requirements, say for cast-iron pipes, such as pump discharge, and suction, low-pressure pipes under vacuum, &c. :—

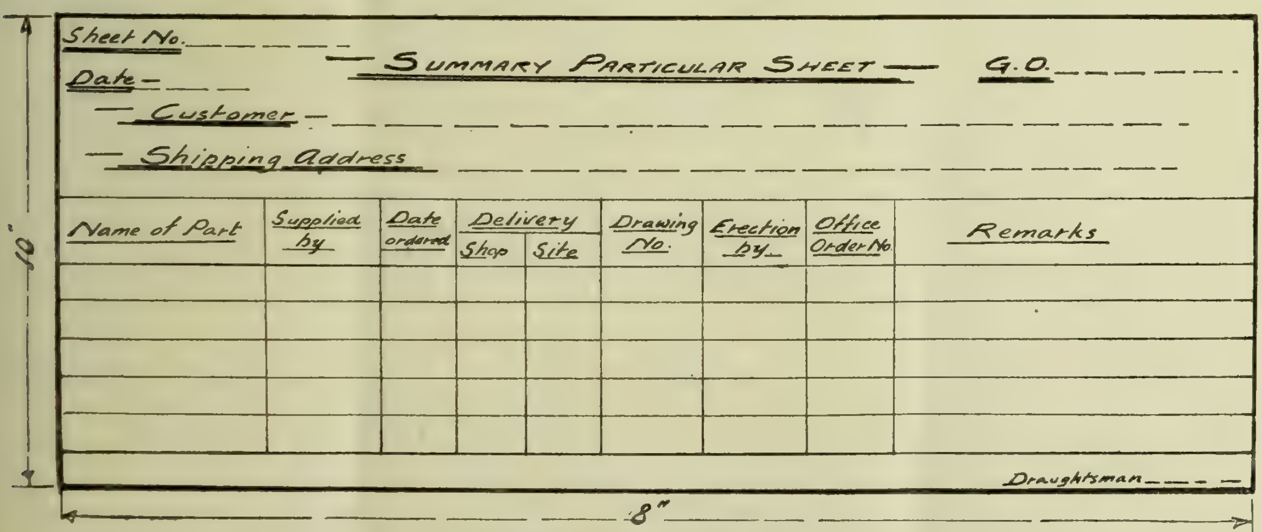
"All flanges to be faced fully across, bolt holes drilled, and flanges spot faced at back.

"All flanges to be British Standard, Table I.

"All pipes to be painted one coat outside after being immersed in Angus Smith's solution.

"All pipes to be tested hydraulically to a pressure of 30 lbs. per square inch before leaving maker's works.

"All pipes to have the item number painted in two places on each pipe."



Engineering Lay-out.—Fig. 86.

In the case of the high-pressure steam piping, the note should include the type of flange required, and also joints, yellow metal rings, or cooperite or other jointing. The test pressure for high-pressure steam mains for pressures up to 225 lbs. per square inch are generally specified and guaranteed by pipe makers at 350 lbs. per square inch.

Before concluding these remarks on the piping, &c., I would like to impress on the reader the importance of making quite clear to the erector on the job what material is ordered outside, and what parts actually come from his firm. In small jobs a note on the general arrangement drawing would suffice, but on large power plants, turbine installations, &c., it is a good plan to make up a short Summary Particular Sheet, as at Fig. 86. These can be printed on thin folio size sheets, thin enough to get blue prints off.

After the draughtsman has filled these in, four copies should be taken off, one for filing in the D.O. file, one for the Shipping Department, one for the Works Manager, and the other for the erector.

By this method anything that is missing on the site can be enquired after by the erector at once. In the case of material ordered outside for direct delivery to site he can get into touch with the firms by telephone and thereby save much time.

A ready check can also be made by the shipping clerk when despatching the various parts, also the draughtsman can see at a glance any time how his job stands *re* deliveries without turning up numerous letters, etc.

(To be continued.)

A METHOD OF CHECKING THE ALIGNMENT OF DIESEL ENGINE SHAFTS, AND A MEANS OF PROVING IF A SHAFT IS ACTUALLY BEDDING IN ITS BEARINGS.*

In regard to the general question of engine maintenance, I am of the opinion, formed from an extended experience, that users who carry out regular periodic overhauls obtain more efficient service out of their engines with a lower average cost of upkeep. It is patent to any user that engines which are overhauled only when they are on the point of breakdown are more costly in upkeep, as generally when such a stage is reached the work has either to be rushed by working the men excessive hours so as to avoid the stoppage being a lengthy one, or a lengthy stoppage is required to carry out the work during ordinary working hours, whereas an annual overhaul and check for alignment would cost less and prevent breakdowns.

The user should realise that it is as much to his interest to keep his engine in first-class condition and thus lessen the risk of stoppage and financial loss both to himself and to the Insurance Companies, just as much as it is the business of the Insurance Companies to see that proper periodic inspections, "thorough" and "running," are carried out by engineers with experience in internal-combustion engine work.

Remembering the large number of hours that Diesel engine plants have had to run in this country to meet the extensive demand for electric power for war purposes, it may naturally be assumed that many of them are in a state requiring considerable overhaul, and as the present period is the most opportune one for this work to be carried out, it was felt that any information which could be put before the members of the Association in connection with overhaul work was especially valuable.

As one of the most important items is the question of alignment of the crank-shaft, I was asked to make a few remarks on this subject, with special reference to a simple and reliable method of detecting "out of alignment."

It will be generally conceded that the alignment of an engine is one of the most important factors in regard to its construction, as, if parts are aligned in a satisfactory manner, there will be greater smoothness of working, less wear and tear, and less tendency to breakdown at critical periods.

It is not essential that an engine bedplate should be absolutely dead level, as would be indicated by a spirit level (although it is certainly of some after value that the engine bedplate should be erected as nearly level as is possible for future reference), but what is more important is that when an engine bedplate is laid down, its shaft should be lying in its bearings parallel with the top machined surface of the bedplate, and the shaft journals should be lying evenly and concentrically in the whole of the bearings in which they will work.

Too much stress cannot be laid on the important factor of the shaft being perfectly parallel with the top of the bedplate, as from the top of the bedplate, generally speaking, the whole of the superstructure and other portions of the engine will be erected, and in the case of a vertical engine which we propose to deal with, these parts should stand correctly at right angles to the top of the bedplate, and therefore to the axis of the shaft. The crank-shaft, formed as it is with large intermittent gaps, produces a comparatively weak structure, and one which is liable to spring under ordinary handling, and great care must be exercised when bedding in a shaft to be sure that it is not strained in any way. Before proceeding to bed in a crank-shaft, precautions should be taken to observe that the bearing shells are bedded accurately, and without spring or slackness into the bedplate housings. The shaft should then be tried in its bearings, and tested for concentricity and roundness of its journals. This is a point which is often overlooked, and neglect of it is certain to produce unsatisfactory running results. If the journals of the shaft are not concentric with each other or are out of round, they should be filed and lapped or remachined. The former course is the one usually adopted. When these parts are fitted the shaft should then be bedded in its bearings, the bearings closed down to their normal running clearance, and the caps screwed hard home. This may be accepted as the usual procedure for bedding in a crank-shaft. The above work can be carried out comparatively easily when all the engine parts are dismantled, and, if at all possible, the rebedding in of a crank-shaft should be carried out in this way.

But we are proposing to consider the question from another point of view, *i.e.*, how to determine when it is necessary that this work should be carried out. We will, therefore, assume that an engine has been at work for some time, and that the engine user is

* A paper read by Mr. George E. Windeler before the Diesel Engine Users' Association on Thursday, 26th June, 1919.

contemplating an overhaul or refit. The chief consideration is time, and naturally he wishes to determine beforehand the amount of work that requires to be carried out. As I have stated before, the most important points to consider with the crank-shaft are:—

(*a*) Is it being properly supported in its bearings?
(*b*) Are the bearings in a satisfactory condition?
(*c*) Are all the bearings, including the outboard bearing or bearings, in alignment with each other?

These important and difficult questions have not hitherto been easy to answer and decide.

I gave this matter very special attention, and proved that the first indication of a shaft being imperfectly supported in its bearings is excessive end play on the shaft with the flywheel running out of truth. In most Diesel engine crank-shafts, the end movement of the shaft is limited by certain thrust collars, and it has been noticed that the end movement referred to has often been seriously in excess of the actual mechanical clearance allowed as end movement. It was this excess that was so disconcerting, and led me to investigate the matter more fully, and to form the opinion that the excessive end movement was produced by the springing of the crank-shaft for want of support, and that actually the shaft was being extended and contracted in length by the opening and closing of the gap between the crank-webs. The difficulty was how to measure this distortion with the engine parts all erected, to decide the amount of want of support, and where the measurement should take place. Having formed the opinion that springing took place between the crank-webs, the next step was to investigate whether the amount could be measured with the engine at rest, and the whole of the reciprocating parts in position, and as it had been determined that the springing took place between the crank-webs, it was decided to measure the distance between the crank-webs with a suitable instrument when the crank-pin was on the top centre, and when the crank-pin was on the bottom centre. Quite interesting results were obtained, and on further pursuing the subject, it was found that a few thousandths difference in the dimensions between the crank-webs when the crank-pin was on the top and bottom centre indicated that the shaft was out of line. This method was found to be especially valuable in regard to checking the alignment of outboard bearings. It was proved that, if a shaft was not being supported at a particular point, by placing the crank-pin of that particular line of parts adjacent to the unsupported bearing at

(*a*) The top centre, and measuring between the crank-webs at a predetermined point, and then
(*b*) Placing the crank-pin on the bottom centre and measuring as before,

a distinct difference was noticed. If the bearing was low the crank-webs would close in when the pin was on the bottom centre, and open out when the pin was on the top centre. If an outerboard was low the reverse was the case, the weight of flywheel causing the crank-webs to open when crank-pin was on the bottom centre, and close in when crank-pin was on top centre. From the readings taken it can readily be determined which bearing or bearings are low, and the higher bearings can then be scraped down to suit. It will be readily understood that this is a simple method which can be applied by anyone, and which does not require any special skill or training, and actual cases will be cited later giving the readings obtained and the deductions formed from them and the amount of out of alignment proved to have existed. Generally speaking, it may be noted that the amount of lack of support or the amount the particular bearing is out of line with other bearings (excepting in the case of the outerboard) is approximately the difference between the readings when the crank-pin is at the top and bottom centre respectively.

The instrument used for these tests was an inside micrometer, having telescopic rods so that variable lengths could be dealt with, but it was found that this instrument required very skilful handling, and it became very obvious that it was necessary to produce a device which could be used by anyone and reliably register the amount of difference in the dimensions taken between the respective crank-webs. Such an instrument was produced, and from its construction it will be quite clear that readings can be readily and reliably taken without any special skill. It will be observed that the special advantage of this method is that you can check at any time without removing any parts, whether the shaft is properly supported or otherwise, and the method is also particularly valuable when rebedding a new bearing into position, as it enables the refit to take place without removing other parts from the engine, and with a certainty that the whole of the bearing will be accurately in line, and that the new bearing will be supporting the shaft properly, and bearing its correct proportion of load. Any other method that I have investigated has invariably proved to be unreliable and unsatisfactory.

(*To be continued.*)

CHIMNEY STACKS.

By James Claughton.

(*Continued from page 8.*)

Report on Boiler Test made at the Electric Power Station, H.M. Dockyard, Chatham.

Carried out by N. B. Rosher, Esq., and Mr. H. A. Hicks.

System of Firing. "Bennis" Sprinkler Stokers and Natural Draught Furnaces.

Date of Test	February 6.
Duration of Test	4 hours.
(A) Particulars of the Boilers Used:—	
Number of boilers	One.
Type of boiler	Dryback marine.
Size of boiler	14′ 6″ × 9′ 9″.
Heating surface of each boiler	2,492 sq. feet.
Plate surface of each boiler	37 sq. feet.
Ratio of heating surface to grate surface	67·35 : 1.
Nature of draught (natural, forced, or induced)	Natural.
Type of mechanical firing apparatus, if any	"Bennis."
Heating surface of economiser, if any	None.
Heating surface of superheater, if any	None.

REPORT OF TEST ON ONE OF MESSRS. RUSTON, PROCTOR & CO., LTD., LANCASHIRE BOILERS, fitted with superheater, and fired by "Bennis" automatic forced draught stoker. The test was carried out at the Luton Corporation Electricity Works by Mr. Geldard, and witnessed by Mr. E. Norris.

	Test No. 1.	Test No. 2
DURATION OF TEST :—	10 hours.	3 hours.
FUEL :—	Slack.	Slack.
Calorific value of coal as fired	10,814 B.Th.U.	10,814 B.Th.U
Total coal fired	13,353 lbs.	4,587·6 lbs.
Coal consumed per hour	1,335·3 lbs.	1,529·2 lbs.
Coal consumed per sq. ft. of grate area per hour	30·34 lbs.	34·75 lbs.
Ash and clinker (residue)	798 lbs.	239·4 lbs.
Percentage of residue to coal burnt	5·96 per cent.	5·23 per cent.
BOILER :—Dimensions, 30′ 0″ × 9′ 0″ diam. ; flues, 3′ 8″ diam.		
Heating surface	1,096 sq. ft.	1,096 sq. ft.
Area of grate	44 sq. ft.	44 sq. ft.
Ratio of heating surface to grate area	24·9.	24·9.
STEAM :—		
Quality	Superheated.	Superheated.
Average pressure per sq. inch	129 lbs.	128·28 lbs.
Saturated steam temperature	353·25 deg. Fah.	353·2 deg. Fah.
Superheated steam temperature	547·47 deg. Fah.	549·4 deg. Fah.
Degree of superheat	194·22 deg. Fah.	196·2 deg. Fah.
WATER :—		
Total evaporated	93,980 lbs.	31,010 lbs.
Evaporated per hour (actual)	9,398 lbs.	10,336·6 lbs.
Evaporated per sq. ft. of heating surface	8·57 lbs.	9·43 lbs.
Evaporated per lb. of coal	7·038 lbs.	6·76 lbs.
Evaporated per hour from and at 212 deg. Fah.	11,070·8 lbs.	12,145·6 lbs.
DRAUGHT :—	Forced draught, fitted.	
At the chimney base (calculated)	·89 in.	·89 in.
In the flue	·812 in.	·812 in.
Over the fire	·4375 in.	·4375 in
TEMPERATURES :—		
Average of feed water	82·8 deg. Fah.	87·0 deg. Fah.
Waste gases	671·25 deg. Fah.	694·2 deg. Fah.
EFFICIENCY :—		
Boiler and superheater	75 per cent.	72 per cent.
CHIMNEY : —		
Height of chimney	125 feet.	125 feet.
Area of chimney	54 sq. ft.	54 sq. ft.

RESULT OF TESTS ON No. 4 "NESDRUM" WATER-TUBE BOILER, with chain grate stokers at Spennymoor Power Station.

DATE OF TEST	February 4th, 1908.	February 4th, 1908.
DURATION OF TEST	4 hours.	2 hours.
Effective heating surface	5,300 sq. ft.	5,300 sq. ft.
Two "Bennis" chain grate stokers, grate area	118 sq. ft.	118 sq. ft.
Average steam gauge pressure per sq. in.	202 lbs.	206 lbs.
Average temperature of feed water to boiler	282·7 deg. Fah.	253·3 deg. Fah.
Coal consumed per hour	2912 = 24·7 lbs. per sq. ft. grate.	2800 = 23·7 lbs. per sq. ft. grate.
Coal consumed per four and two hours respectively	11,648 lbs.	5,600 lbs.
Water evaporated per lb. of coal under actual conditions	8·47 lbs.	10 lbs.
Water evaporated in four and two hours respectively	98,750 lbs.	56,000 lbs.
Average water evaporated per hour, actual conditions	24,685 lbs.	28,000 lbs.
Water evaporated per sq. ft. heating surface from feed temperature	4·65 lbs.	5·3 lbs.
Temperature of flue gases at boiler side of dampers	547 deg. Fah.	610 deg. Fah.
Draught in inches of water at boiler damper	1·02	1·02.4
Average temperature of superheated steam at boiler	547 deg. Fah. 106 deg. Fah.	552 deg. Fah. 171 deg. Fah.
Average temperature of superheated steam at turbo	540 deg. Fah.	542 deg. Fah.
Average temperature of feed water to economiser	110 deg. Fah.	110 deg. Fah.
Kind of coal used	Sheldon coal.	Adelaide slack.
Total heat value of coal by Thompson's calo.	12,625 B.Th.U.	13,300 B.Th.U.
Efficiency of boiler	63·5 per cent.	73·26 per cent.
Efficiency of boiler with superheater	69·14 per cent.	79·26 per cent.
Efficiency of boiler with superheater and economiser	80·72 per cent.	90·59 per cent.
Mean efficiency of boiler for 6 hours		68·38 per cent.
Mean efficiency of boiler with superheater for 6 hours		74·42 per cent.
Mean efficiency of boiler with superheater and economiser for 6 hours		85·650 per cent.

(B) CONDITIONS OF COMBUSTION (AVERAGES):

Draught in inches of water gauge over fires	·40 inches.
Draught in inches of water gauge in uptake	·60 ,,
Draught in inches of water gauge at chimney base	·75 ,,
Temperature of flue gases leaving boiler	635 deg. Fah.
Temperature of flue gases uptake	410 deg. Fah.
Temperature of gases in main flue	262 deg. Fah.
Percentage of CO_2 in flue gases at downtake	Not taken.
Percentage of CO_2 in flue gases leaving boiler	12·7 per cent.
Smoke produced during test	None.

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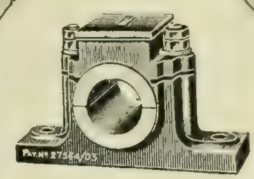

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Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 43 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 3 10	7 2 20	11 2 2	15 1 12	0 19 0 22	1 3 0 4	1 6 3 14	1 10 2 24	1 14 2 6	0
1	0 1 15	4 0 25	8 0 7	11 3 17	15 2 27	0 19 2 9	1 3 1 19	1 7 1 1	1 11 0 11	1 14 3 21	1
2	0 3 2	4 2 12	8 1 22	12 1 4	16 0 14	0 19 3 24	1 3 3 6	1 7 2 16	1 11 1 26	1 15 1 8	2
3	1 0 17	4 3 27	8 3 9	12 2 19	16 2 1	1 0 1 11	1 4 0 21	1 8 0 3	1 11 3 13	1 15 2 23	3
4	1 2 4	5 1 14	9 0 24	13 0 6	16 3 16	1 0 2 26	1 4 2 8	1 8 1 18	1 12 1 0	1 16 0 10	4
5	1 3 19	5 3 1	9 2 11	13 1 21	17 1 3	1 1 0 13	1 4 3 23	1 8 3 5	1 12 2 15	1 16 1 25	5
6	2 1 6	6 0 16	9 3 26	13 3 8	17 2 18	1 1 2 0	1 5 1 10	1 9 0 20	1 13 0 2	1 16 3 12	6
7	2 2 21	6 2 3	10 1 13	14 0 23	18 0 5	1 1 3 15	1 5 2 25	1 9 2 7	1 13 1 17	1 17 0 27	7
8	3 0 8	6 3 18	10 3 0	14 2 10	18 1 20	1 2 1 2	1 6 0 12	1 9 3 22	1 13 3 4	1 17 2 14	8
9	3 1 23	7 1 5	11 0 15	14 3 25	18 3 7	1 2 2 17	1 6 1 27	1 10 1 9	1 14 0 19	1 18 0 1	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	3·59	7·18	10·77	14·36	17·95	21·54	25·13	1 0·72	1 4·31	1 7·9	1 11·49	1 15	

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 43 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	1 18 1 16	3 16 3 4	5 15 0 20	7 13 2 8	9 11 3 24	11 10 1 12	13 8 3 0	15 7 0 16	17 5 2 4	0
10	0 3 3 10	2 2 0 26	4 0 2 14	5 19 0 2	7 17 1 18	9 15 3 6	11 14 0 22	13 12 2 10	15 10 3 26	17 9 1 14	10
20	0 7 2 20	2 6 0 8	4 4 1 24	6 2 3 12	8 1 1 0	9 19 2 16	11 18 0 4	13 16 1 20	15 14 3 8	17 3 0 24	20
30	0 11 2 22	2 9 3 18	4 8 1 6	6 6 2 22	8 5 0 10	10 3 1 26	12 1 3 14	14 0 1 2	15 18 2 18	17 17 0 6	30
40	0 15 1 12	2 13 3 0	4 12 0 16	6 10 2 4	8 8 3 20	10 7 1 8	12 5 2 24	14 4 0 12	16 2 2 0	18 0 3 16	40
50	0 19 0 22	2 17 2 10	4 15 3 26	6 14 1 14	8 12 3 2	10 11 0 18	12 9 2 6	14 7 3 22	16 6 1 10	18 4 2 26	50
60	1 3 0 4	3 1 1 20	4 19 3 8	6 18 0 24	8 16 2 12	10 15 0 0	12 13 1 16	14 11 3 4	16 10 0 20	18 8 2 8	60
70	1 6 3 14	3 5 1 2	5 3 2 18	7 2 0 6	9 0 1 22	10 18 3 10	12 17 0 26	14 15 2 14	16 14 0 2	18 12 1 18	70
80	1 10 2 24	3 9 0 12	5 7 2 0	7 5 3 16	9 4 1 4	11 2 2 20	13 1 0 8	14 19 1 24	16 17 3 12	18 16 1 0	80
90	1 14 2 6	3 12 3 22	5 11 1 10	7 9 2 26	9 8 0 14	11 6 2 2	13 4 3 8	15 3 1 6	17 1 2 22	19 0 0 10	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	19 3 3 20	38 7 3 12	57 11 3 4	76 15 2 24	95 19 2 16	115 3 2 8	134 7 2 0	153 11 1 20	172 15 1 12	191 19 1 4	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 45 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 0 2	8 0 4	12 0 6	16 0 8	1 0 0 10	1 4 0 12	1 8 0 14	1 12 0 16	1 16 0 18	0
1	0 1 17	4 1 19	8 1 21	12 1 23	16 1 25	1 0 1 27	1 4 2 1	1 8 2 3	1 12 2 5	1 16 2 7	1
2	0 3 6	4 3 8	8 3 10	12 3 12	16 3 14	1 0 3 16	1 4 3 18	1 8 3 20	1 12 3 22	1 16 3 24	2
3	1 0 23	5 0 25	9 0 27	13 1 1	17 1 3	1 1 1 5	1 5 1 7	1 9 1 9	1 13 1 11	1 17 1 13	3
4	1 2 12	5 2 14	9 2 16	13 2 18	17 2 20	1 1 2 22	1 5 2 24	1 9 2 26	1 13 3 0	1 17 3 2	4
5	2 0 1	6 0 3	10 0 5	14 0 7	18 0 9	1 2 0 11	1 6 0 13	1 10 0 15	1 14 0 17	1 18 0 19	5
6	2 1 18	6 1 20	10 1 22	14 1 24	18 1 26	1 2 2 0	1 6 2 2	1 10 2 4	1 14 2 6	1 18 2 8	6
7	2 3 7	6 2 9	10 3 11	14 3 13	18 3 15	1 2 3 17	1 6 3 19	1 10 3 21	1 14 3 23	1 18 3 25	7
8	3 0 24	6 3 16	11 1 0	15 1 2	19 1 4	1 3 1 6	1 7 1 8	1 11 1 10	1 15 1 12	1 19 1 14	8
9	3 2 13	7 2 15	11 2 17	15 2 19	19 2 21	1 3 2 23	1 7 2 25	1 11 2 27	1 15 3 1	1 19 3 3	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 3·75	0 7·5	0 11·25	0 15·0	0 18·75	0 22·5	0 26·25	1 2	1 5·75	1 95	1 13·25	1 17	

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 45 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 0 0 20	4 0 1 12	6 0 2 4	8 0 2 24	10 0 3 16	12 1 0 8	14 1 1 0	16 1 1 20	18 1 2 12	0
10	0 4 0 2	2 4 0 22	4 4 1 14	6 4 2 6	8 4 2 26	10 4 3 18	12 5 0 10	14 5 1 2	16 5 1 22	18 5 2 14	10
20	0 8 0 4	2 8 0 24	4 8 1 16	6 8 2 8	8 8 3 0	10 8 3 20	12 9 0 12	14 9 1 4	16 9 1 24	18 9 2 16	20
30	0 12 0 6	2 12 0 26	4 12 1 18	6 12 2 10	8 12 3 2	10 12 3 22	12 13 0 14	14 13 1 6	16 13 1 26	18 13 2 18	30
40	0 16 0 8	2 16 1 0	4 16 1 20	6 16 2 12	8 16 3 4	10 16 3 24	12 17 0 16	14 17 1 8	16 17 2 0	18 17 2 20	40
50	1 0 0 10	3 0 1 2	5 0 1 22	7 0 2 14	9 0 3 6	11 0 3 26	13 1 0 18	15 1 1 10	17 1 2 2	19 1 2 22	50
60	1 4 0 12	3 4 1 4	5 4 1 24	7 4 2 16	9 4 3 8	11 5 0 0	13 5 0 20	15 5 1 12	17 5 2 4	19 5 2 24	60
70	1 8 0 14	3 8 1 6	5 8 1 26	7 8 2 18	9 8 3 10	11 9 0 2	13 9 0 22	15 9 1 14	17 9 2 6	19 9 2 26	70
80	1 12 0 16	3 12 1 8	5 12 2 0	7 12 2 20	9 12 3 12	11 13 0 4	13 13 0 24	15 13 1 16	17 13 2 8	19 13 3 0	80
90	1 16 6 18	3 16 1 10	5 16 2 2	7 16 2 22	9 16 3 14	11 17 0 6	13 17 0 26	15 17 1 18	17 17 2 10	19 17 3 2	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	20 1 3 4	40 3 2 8	60 5 1 12	80 7 0 16	100 8 3 20	120 10 2 24	140 12 2 0	160 14 1 4	180 16 0 8	200 17 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

(C) Conditions of Evaporation (Averages): –	
Temperature of feed water—entering boiler	100·0 deg. Fah.
Steam pressure by gauge	165·0 lbs. per sq in.
Corresponding saturation temperature	372·9 deg. Fah.
Heat supplied to each lb. of water in boiler	1,127·7 B.Th.U.
Factor of equivalent evaporation as from and at 212 deg. Fah. (boiler only)	1·1676.
(D) Nature of Coal used :—	
Name of coal	West Hartley.
Class of coal	Rough slack.
Calorific value of coal per lb., as fired	12,006 B.Th.U.
Approximate analysis of coal : ash	7·1 per cent.
(E) Quantity of Coal Used :—	
Total weight of coal burnt	5,785 lbs.
Coal burnt per boiler per hour	1,446 lbs.
Coal burnt per sq. ft. grate surface per hour	39·09 lbs.
Total weight of ash and clinker	423 lbs.
Percentage of ash and clinker to weight of coal	7·3 per cent.
(F) Quantity of Water Evaporated (Actual) :—	
Total quantity of water evaporated	47,260 lbs.
Water evaporated per boiler per hour	11,815 lbs.
Water evaporated per sq. ft. boiler heating surface per hour	4·74 lbs.
Water evaporated per lb. of coal	8·17 lbs.
Total heat supplied to water per lb. of coal	9,213 B.Th.U.
(G) Equivalent Quantity of Water Evaporated, as from and at 212 deg. Fah.	
Total equivalent evaporation	55,182 lbs.
Equivalent evaporation per boiler per hour	13,795 lbs.
Equivalent evaporation per sq. ft. boiler heating surface per hour	5·54 lbs.
Equivalent evaporation per lb. of coal	9·54 lbs.
(H) Efficiency and Economic Results :—	
Total thermal efficiency obtained	76·73 per cent.
Summary of Results.	
Coal burnt per sq. ft. grate surface per hour	39·09 lbs.
Water evaporated, as from and at 212 deg. Fah. per sq. ft. boiler heating surface per hour	5·54 lbs.
Water evaporated, as from and at 212 deg. Fah. per lb. of coal	9·54 lbs.
Total thermal efficiency obtained	76·73 per cent.

(To be continued.)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from Vol. VII., page 474.)

The Use of Powdered Fuel.

Yet another subject has cropped up, while these articles have been going through, which the writer thinks he had better deal with, before passing on to economies in the use of the steam. Readers will probably have read of the use of powdered fuel, from time to time; the subject has cropped up at intervals for a good many years past; every now and then it has been stated that the problems involved in its use have been solved, and then later one has heard that plant that had been put down for using powdered fuel has been displaced; or in other cases that, while it has remained in use at the places where it had been mentioned, no one else appears to have taken it up.

This may have been due partly to the indifference with which the question of economies in the generation of steam has been regarded, and partly to difficulties inherent in the apparatus required to enable powdered fuel to be used; and again, the writer suggests that probably the development and success of the mechanical stoker has caused the question of powdered fuel to be passed by. It will be remembered that while the mechanical stoker requires the addition of certain apparatus to the boiler furnace, once they are fixed, and the boiler attendants have got used to looking after them, or skilled attendants have been put in their place, there is not much trouble beyond the question of repairs. Repairs with mechanical stokers are often rather a serious item, but the whole thing is more easily applied, and apparently leads to more direct economy than the use of powdered fuel. With the advent of the mechanical stoker the question of the fuel to be bought was revolutionised; before, it was an axiom that it was cheaper to buy the very best lump coal for use in boiler furnaces, because fires could be kept going better, with less trimming, in the hands of a capable stoker than with inferior coal; the result being that the pressure of steam was kept more regular, and so the gain to the works was usually greater than the saving due to the difference in the cost with inferior coal. The mechanical stoker changed all this, it allowed every quality of coal right down to the most inferior to be used, and consequently the reason for using powdered fuel disappeared. The idea, as the writer understands it, of the inventors of powdered fuel apparatus some 15 years ago was to enable low-grade fuels to be employed, by crushing them to a fine powder, and delivering them to the boiler furnace in that condition, by various devices, much in the same manner as oil and gas were then beginning to be used for the purpose. As it is necessary in every case to employ somewhat expensive apparatus to crush the coal down to the very fine powder that can be used with powdered fuel systems, immediately the mechanical stoker enabled low-grade fuels of all kinds, slack, breeze, and other fuels that had previously been wasted, to be employed, the cost of powdering the fuel put it out of court. About 15 years ago the writer understands that a powdered fuel plant was in use in Lancashire, and was then reported to be doing very well; he has not heard anything about it recently. At that time it was hoped to reduce the cost of preparing the fuel in the powdered state to one shilling per ton, but all estimates up to that date gave the figures as higher than one shilling, and with the advent of the successful mechanical stoker, one shilling proved to be too great a handicap.

But the recent war has altered many things; in particular it appears to be necessary that we should get every atom of coal out of the pits, and burn it, instead of leaving a proportion of it in the gob, etc.

The mechanical stoker should enable all the coal that has hitherto been wasted, that has been left in the gob, etc., to be used; but there is the question of getting it to the surface. Readers will have read, a few weeks ago, accounts in the papers of a strike in some of the collieries in Leicestershire, against the continued enforcement by the management of the use of the fork for filling coal into the mine wagons in the place of the shovel. The fillers wished to use the shovel, which would be a distinct advantage to them, as they are paid by the

ton; but it would mean that a lot of the smaller stuff would be filled into the mine wagons, and be brought to bank. In South Wales, for a very long time, small coal was not paid for; at nearly every colliery in the district there was a machine attached to the coaling screens for weighing the small that passed through them, the amount of small coal being deducted from the total weight of coal in the tub as it passed over the platform of the weighing machine.

The writer has alluded to this matter at this point because it appears to him that the latest method of dealing with powdered fuel, by means of air currents, might be applied to bring the small coal, etc., out of the pit; it appears to him also that by the same methods the small might be conveyed over comparatively long distances to a central station, say in the neighbourhood of one of the super power stations that are to be laid down in the future, where it might be dealt with as necessary to reduce it to the condition in which it can be employed as powdered fuel.

Methods of Preparing the Fuel.

The fuel that is to be used in the powdered state has to be reduced to a very fine consistency; that which is employed in the most recent method that is being placed on the market has to go through what is known as a 200-mesh screen, one having 200 perforations per inch in every direction, that is to say, 40,000 to the square inch; 85 per cent of the powder has to pass through this screen, to be of sufficient fineness to do so, and 95 per cent through a 100-mesh screen, having 10,000 perforations per square inch.

The fuel has also to be dried, and this is usually done before the pulverising takes place. Where large coal is used, it is broken up by a crusher to the size of one inch cube, before passing to the pulverising mill. There are several forms of pulverising mills on the market; the problem involved in grinding up coal to the very fine consistency required is very similar to that of grinding up the rock that is brought out of gold and tin mines. It will be remembered that in those industries the quantity of metal in the rock is very minute; in the case of gold mines, it is a very good proposition if there is one ounce of metal gold in a ton of the native rock, while propositions in which the amount is as low as six pennyweights are profitably worked. In tin mines the yield is larger, but the amount of grinding that has to be done is very nearly as much. In the Portland cement industry also a great deal of grinding of the materials that are afterwards burnt together to form the cement has to be accomplished. The result of this has been that a number of firms have devoted themselves to the working out of special forms of apparatus; special mills designed to grind up the different substances to the fineness mentioned above. There are broadly two principal forms of grinding apparatus on the market; in one form, rollers rotate inside rings, or cylinders, specially arranged for the purpose, the material to be crushed being fed into the space between the rollers and the containing cylinder. In a modification of this, the rollers are divided up, several rollers rotating independently inside of the containing cylinder; and in a further modification, the rollers are replaced by other forms, all intended to catch all the material and to keep it subject to some part of the crushing members until it is reduced to the consistency required.

(To be continued.)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Continued from page 32.)

Having now determined the value of all the A's, the B's and C's may readily be found, thus:

$$B_1 = A_1 = \cdot 0006933$$

$$C_1 = \frac{A_6}{B_1 + A_3} = \frac{\cdot 0007641}{\cdot 0006933 + \cdot 0004366} = \cdot 6763$$

$$B_2 = y_5 - A_4 C_1 = \cdot 001473 - \cdot 0007641 \times \cdot 6763 = \cdot 0009562$$

$$C_2 = \frac{A_{10}}{B_2 + A} = \frac{\cdot 001234}{\cdot 0009562 + \cdot 0009875} = \cdot 6349$$

$$B_3 = A_9 - A_8 C_2 = \cdot 001568 - \cdot 001234 \times \cdot 6349 = \cdot 007845$$

It may be also noted that:

$$W_2 = \frac{W_1}{C_1} = \frac{W_1}{\cdot 6763} = 1\cdot 479\, W_1$$

and

$$W_3 = \frac{W_2}{C_2} = \frac{1\cdot 479 W_1}{\cdot 6349} = 2\cdot 330\, W_1.$$

The strength modulus for bending of plate No. 1 being $Z = .01172$, then if we allow, for convenience of calculation, a maximum stress of 100,000 lb. per square inch, the safe load W_1 will be $\frac{100000 \times \cdot 01172}{4}$ $= 293$ lb. $W_2^1 = 293 \times 1.479 = 433$ lb., and W_3, which is the safe load on the three-leaf cantilever spring, will be $293 \times 2.330 = 683$ lb. Also, as the deflection is B_3 inches per pound of W_3, the stiffness of the spring is $\frac{1}{B_3} = 1{,}275$ lb. load per inch deflection.

The bending moment in plate No. 2, directly over the tip of plate No. 1, is $433 \times 2 = 866$ in. lb., and as $Z_2 = .01595$ the stress is $866/.01595 = 54{,}290$ lb. per square inch. At the centre the bending moment is $433 \times 6 - 293 \times 4 = 1{,}426$ in. lb. with a stress of 89,400 lb. per square inch.

For plate No. 3, the bending moment directly over the tip of plate No. 2 is $683 \times 1 = 683$ in. lb. with a stress of 32.770 lb. per square inch, and at the centre the bending moment is $683 \times 7 - 433 \times 6 = 2{,}183$ in. lb. with a stress of 104,750 lb. per square inch.

This last result is interesting, as it shows a slightly higher stress in the master leaf than in the short one; as previously mentioned, this is not of common occurrence and cannot occur with a non-graded, non-tapered spring, but it may and sometimes does occur with graded and tapered springs. The new theory thus accounts for the observed facts, that with some types of springs the short leaf nearly always breaks first, while with other springs—as in the particular case just given—it is the master leaf which is usually the first to fracture. There are, of course, intermediate conditions, when one of the intermediate leaves is most apt to break, but these are few in comparison with the cases of fracture of either the short or the master leaf.

The square-point leaf is in such general use, especially for the heavier grades of springs, that it is desirable to simplify, as much as possible, the calculations for the reactions and deflections of this style of spring. This can be done to a considerable extent in the following manner:

Referring back to the fundamental equation (7),

it will be found that this can be rewritten as follows:

$$2W_n\left(\frac{I_{n+1}}{I_n}+1\right)-W_{n-1}\frac{I_{n+1}}{I_n}\left\{\frac{\left(\frac{l_{n-1}}{l_n}\right)^3\left(3\frac{l_n}{l_{n-1}}-1\right)}{3\frac{l_{n+1}}{l_n}-1}\right\}\quad\ldots(25)$$

and if we write

P_n for $\frac{I_{n+1}}{I_n}$, Q_n for $\frac{l_{n+1}}{l_n}$, and R_{n-1} for $\frac{3Q_{n-1}-1}{Q^3_{n-1}}$

we obtain:

$$W_{n+1}=\frac{2W_n(P_n+1)-W_{n-1}P_nR_{n-1}}{3Q_n-1}\quad\ldots\ldots\ldots\ldots\ldots\ldots(26)$$

which is reasonably simple formula for practical manipulation.

In order to facilitate the practical use of this equation (26) we have calculated the values of the function of Q_{n-1} denoted by R_{n-1}, and these are given in Table No. VII.

In order to show the utility of this equation and table, we will now work out the same spring (Fig. 17) that we have solved above, by this method.

First find the values of the P's and Q's, thus:

$$P_1 = \cdot001754/\cdot001099 = 1\cdot588$$
$$P_2 = \cdot002604/\cdot001745 = 1\cdot1\cdot492$$
$$Q_1 = 6/4 = 1\cdot500$$
$$Q_2 = 7/6 = 1\cdot167$$

R_1 is to be taken from Table VII., opposite the value of Q_1, or 1.500, where we find $R_1 = 1.0370$. For R_2, corresponding to Q_2, we find 1.5888 as the tabular value corresponding to 1.16, with a first difference of 216 and $216 \times .7 = 151$, which must be *subtracted* from the 1.5888 since R decreases as Q increases, thus giving 1.5737 as the value of R_2.

Next inserting these values in equation (26) and putting $W_1 = 1$ we have, since $W_0 = o$:

$$W_2 = \frac{2(P_1+1)}{3Q_1-1} = \frac{2(\cdot1588+1)}{3\times1\cdot5-1} = 1\cdot479$$

$$W_3 = \frac{2W_2(P_2+1)-W_1P_2R_1}{3Q_2-1}$$

$$= \frac{2\times1\cdot478(1\cdot492+1)-1\cdot492\times1\cdot037}{3\times1\cdot167-1} = 2\cdot327$$

these values being almost exactly the same as before —if more figures were taken they would be exactly the same, and in any case the differences are practically negligible.

The same table (VII.) can be used for simplifying the deflection calculations, for the deflection coefficient B_n may be written in the form:

$$B_n = \frac{K_n l^3_n}{6\,EI_n}\quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(27)$$

where:

$$K_n = 2 - \frac{W_{n-1}}{W_n}R_{n-1}\quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(28)$$

To apply this to the above case, we have $n = 3$ for the three-plate spring,

$$I_3 = \cdot002604,\ l_3 = 7,\ W_2 = 1\cdot479,\ W_3 = 2\cdot327.$$

$$K_3 = 2 - \frac{W_2R_2}{W_3} = 2 - \frac{1\cdot479\times1\cdot5737}{2\cdot327} = \cdot9995$$

and

$$B_3 = \frac{\cdot9995\times7^3}{6\times28\times10^6\times\cdot002604} = \cdot0007837$$

which is sensibly the same as obtained before. It will easily be seen that this method of calculation

TABLE VII.

Q_{n-1}	R_{n-1}	Diff.	Q_{n-1}	R_{n_1-}	Diff.
1.00	2.0000	297	1.76	.7851	79
1.01	1.9703	291	1.77	.7772	77
1.02	1.9412	285	1.78	.7695	76
1.03	1.9127	280	1.79	7619	74
1.04	1.8847	274	1.80	.7545	74
1.05	1.8573	269	1.81	.7471	73
1.06	1.8304	264	1.82	.7398	72
1.07	1.8040	258	1.83	.7326	70
1.08	1.7782	253	1.84	.7256	70
1.09	1.7529	249	1.85	.7186	69
1.10	1.7280	243	1.86	.7117	67
1.11	1.7037	239	1.87	.7050	67
1.12	1.6798	234	1.88	.6983	66
1.13	1.6564	230	1.89	.6917	65
1.14	1.6334	225	1.90	.6852	64
1.15	1.6109	221	1.91	.6788	63
1.16	1.5888	216	1.92	.6725	63
1.17	1.5672	213	1.93	.6662	61
1.18	1.5459	208	1.94	.6601	60
1.19	1.5251	205	1.95	.6541	60
1.20	1.5046	200	1.96	.6481	59
1.21	1.4846	197	1.97	.6422	58
1.22	1.4649	193	1.98	.6364	57
1.23	1.4456	190	1.99	.6307	57
1.24	1.4266	186	2.00	.6250	111
1.25	1.4080	193	2.02	.6139	108
1.26	1.3897	179	2.04	.6031	105
1.27	1.3718	176	2.06	.5926	103
1.28	1.3542	173	2.08	.5823	100
1.29	1.3369	169	2.10	.5723	98
1.30	1.3200	167	2.12	.5625	95
1.31	1.3033	163	2.14	.5530	94
1.32	1.2870	161	2.16	.5438	91
1.33	1.2709	158	2.18	.5347	88
1.34	1.2551	155	2.20	.5259	86
1.35	1.2396	152	2.22	.5173	84
1.36	1.2244	149	2.24	.5089	82
1.37	1.2095	147	2.26	.5007	80
1.38	1.1948	144	2.28	.4927	78
1.39	1.1804	142	2.30	.4849	76
1.40	1.1662	140	2.32	.4773	75
1.41	1.1522	136	2.34	.4698	72
1.42	1.1386	135	2.36	.4626	72
1.43	1.1251	132	2.38	.4554	69
1.44	1.1119	130	2.40	.4485	68
1.45	1.0989	128	2.42	.4417	66
1.46	1.0861	126	2.44	.4351	65
1.47	1.0735	124	2.46	.4286	64
1.48	1.0611	121	2.48	.4222	62
1.49	1.0490	120	2.50	.4160	61
1.50	1.0370	117	2.52	.4099	59
1.51	1.0253	116	2.54	.4040	58
1.52	1.0137	113	2.56	.3982	57
1.53	1 0024	112	2 58	.3925	56
1.54	.9912	110	2.60	.3869	55
1.55	.9802	109	2.62	.3814	53
1.56	.9693	106	2.64	.3761	52
1.57	.9587	105	2.66	.3709	52
1.58	.9482	103	2.68	.3657	50
1.59	.9379	102	2.70	3607	49
1.60	.9277	100	2.72	.3558	48
1.61	.9177	98	2.74	.3510	47
1.62	.9079	97	2.76	.3463	47
1.63	8982	95	2.78	.3416	45
1.64	.8887	94	2.80	.3371	44
1.65	.8793	92	2.82	.3327	44
1.66	.8701	91	2.84	.3283	43
1.67	.8610	90	2.86	.3240	42
1.68	.8520	88	2.88	.3198	41
1.70	.8345	85	2.90	.3157	40
1.69	.8432	87	2.92	.3117	40
1.71	.8260	95	2.94	.3077	39
1.72	.8175	83	2.96	.3038	38
1.73	.8092	81	2.98	.3000	37
1.74	.8011	81	3.00	.2963	
1.75	.7930	79			

greatly reduces the labour of computation in cases where square-point leaves are concerned. For most practical cases where the leaf ends are "trap" points the present formulæ may be used—we shall see that this is the case in the later portion of the present paper.

(To be continued.)

MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from Vol. VII., page 375.)

The manufacture of steam turbines was taken up by Messrs. Fraser and Chalmers, of Erith, Kent, in the year 1905. A great deal of consideration was given to the relative advantages of impulse and reaction turbines, and finally the firm decided to build machines of the former type. The general principle of this kind of turbine has already been adequately dealt with, and it will suffice to call attention to the constructional details of the turbines built by this firm. Such details as glands, bearings, oil throwers, and so forth need not be described, for they are very similar to those used on other impulse turbines built on the best and most up-to-date lines. At the high-pressure end of the turbine shaft is the usual worm which drives the

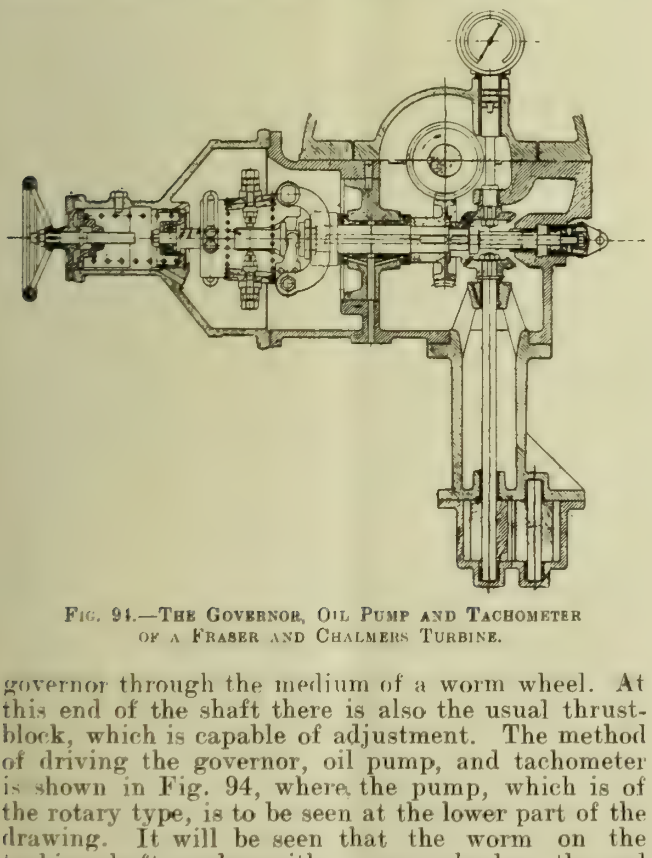


Fig. 94.—The Governor, Oil Pump and Tachometer of a Fraser and Chalmers Turbine.

governor through the medium of a worm wheel. At this end of the shaft there is also the usual thrust-block, which is capable of adjustment. The method of driving the governor, oil pump, and tachometer is shown in Fig. 94, where the pump, which is of the rotary type, is to be seen at the lower part of the drawing. It will be seen that the worm on the turbine shaft meshes with a worm wheel on the end of the governor spindle, and that the pump and tachometer are driven by means of bevel gears. The pump is always flooded with oil, which passes from the bearings and oil relay into the oil chamber in the bedplate of the turbine, from which the pump draws the oil. On its way back to the chamber the oil passes through a strainer. Moreover, the oil also passes through a cooler, which prevents the temperature of the oil attaining too high a value. For flooding the bearings before starting the turbine, a small hand-operated or steam turbo-operated pump is provided.

It will be gathered from Fig. 94 that the governor is of the centrifugal flyball type, the movement of the governor being transmitted to an oil relay which in turn controls the throttle valve. By means of the

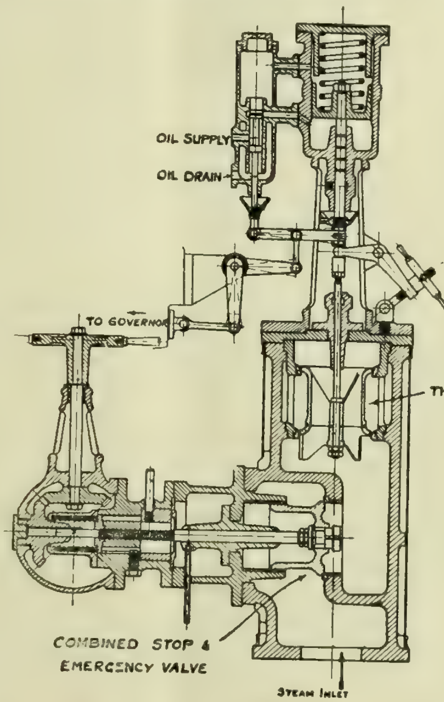


Fig. 95.—The Stop and Throttle Valves for a High-pressure Fraser and Chalmers Turbine.

handwheel to be seen on the left of Fig. 94, the speed of the turbine can be regulated within the limits of 5 per cent above or below the normal speed. If desired, this regulating gear can, of course, be coupled up to a small electric motor when the speed of the turbine can be regulated at will from the switchboard. The emergency governor which shuts off the supply of steam in the event of the speed of the turbine becoming excessive, is fitted at the high-pressure end of the turbine shaft, and consists of a small plunger at right-angles to the axis of the shaft, the centre of gravity of this plunger being out of line with the centre of the turbine shaft. Normally, the plunger is prevented from moving outwards by a spring, but when the speed exceeds a certain value, the centrifugal force acting on the plunger overcomes the spring and the plunger flies outwards and releases a catch, and so causes the emergency governor to close. Simultaneously, the oil supply to the relay cylinder is interrupted with the result that the throttle valve also closes under the action of a spring. The emergency gear can easily be released by hand if it should be necessary to shut down the turbine quickly.

Details of the main-stop valve and throttle valve are shown in Fig. 95, from which it will be seen that

both valves are fitted to a steam chest which is bolted to the turbine casing. The stop valve not only serves for starting the turbine, but also acts as the emergency valve in the event of the steam speed becoming excessive. The throttle valve, it will be noticed, is of the double-seat pattern, and it is provided with ports in order that it may give steady governing. If desired, Messrs. Fraser and Chalmers fit their turbines with an overload valve, which opens automatically in the event of the load attaining a high value. In this case, however, the oil relay only operates upon the overload valve when the main throttle valve is wide open, and the overload valve closes again immediately the load drops to normal.

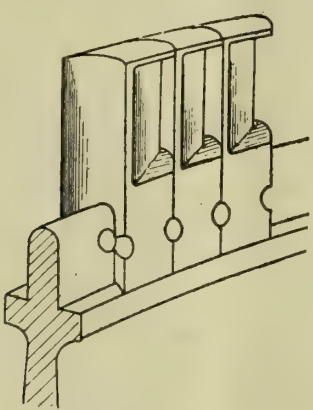


Fig. 96.—Method of Fixing the Short Blades of a Fraser and Chalmers Turbine.

The running wheels of the Fraser and Chalmers turbines are composed of solid steel forgings machined all over, and proportioned so as to have uniform strength throughout. Holes are bored in the wheels so as to ensure that the pressure on both sides of each wheel is the same. After the wheels have been bladed they are carefully balanced and then tested at a speed considerably higher than the normal running speed. The blades (see Figs. 96 and 97) are of a special and patented type. They are milled out of solid bars, and the lower end of each blade, as shown, is provided with a fork for fixing it to the periphery of the wheel to which it is secured by counter-sunk rivets. The longest blades (see Fig. 97) are held at the outer end by a cover band or shrouding, thus making the fixing very stiff and at the same time providing a good guide for the flow of steam. In the case of the shorter blades, however, a guide-piece is milled out of each blade at the upper extremity and the guide-piece of each blade butts against the back of the adjacent blade as shown in Fig. 96, the result being that any blade can be removed from a wheel on removing the rivets without in any way disturbing the other blades. A great deal of attention has been given to the selection of the material for making these blades and, after much experimental work, the firm has come to the conclusion that the nickel steel, containing 5 per cent nickel, is the best material that can be used. Experiece shows that high percentage nickel steel or brass or bronze are less suitable than 5 per cent nickel steel for impulse turbines. The surfaces of the milled bars are not too hard, and the makers have found that the blades are more elastic than drawn blades. It will be understood, of course, that the forks of the blades serve as distance pieces. The clearances between the moving blades and the stationary diaphragms are not less than an eighth of an inch, and the radial clearances between the moving blades and casing not less than a quarter of an inch.

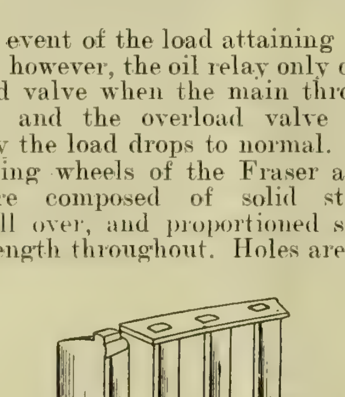


Fig. 97.—The Method of Fixing the Long Blades of a Fraser and Chalmers Turbine.

(To be continued.)

SOME NOTES ON THE CHOICE AND INSTALLATION OF ELECTRIC MOTORS.

By G. W. Stubbings.

The enormous increase in the use of electricity for industrial power purposes during the recent war provides the best evidence of the general desirability of electricity for this purpose. Experience has, however, shown that the advantages of electricity in this connection can only be fully realised when due care and thought are expended on the choice of the motors and switch gear installed, and also upon the general design and installation of the plant as a whole. Lack of attention to these points will entail the sacrifice of a good deal of the efficiency which can be obtained by the use of electricity for power purposes, and will, moreover, go far to introduce the element of unreliability of operation.

It is well known that in the majority of the older power plants, consisting of a number of machines driven through long lines of shafting by a single prime mover of the gas or steam engine type, the bulk of the power generated was expended in turning the shafting round. This was partly due to the fact that the transmission of power by means of belting is necessarily inefficient, and also to the fact that the maintenance of the shafting received but scant attention. One of the greatest advantages of the electric drive is that it enables power to be transmitted from a central point of generation or supply, through the medium of electric cables, without appreciable loss, to as many points as may be desired. The

necessity for long lines of shafting is therefore abolished, as the number of motors that can be installed is not limited by any losses of electric transmission. The actual limit of the number of motors is, of course, reached when each machine is provided with a separate motor. By adopting this plan the amount of shafting would be reduced to a minimum, but other disadvantages would be introduced. In the first place, many of the motors would be of small sizes, and would therefore operate at very much lower efficiencies than those of larger outputs, and, further, the multiplication of the number of motors in use would greatly increase the capital expenditure. It is, therefore, customary to arrange for several machines to be driven by a single motor, the size of the motor, the number of machines it drives, and the system of transmission of power from the motor to the machines being vital factors upon which the success of the whole installation will depend.

The transmission of power from the motor to the various machines is carried out usually by means of belts and shafting, and here it is that every effort should be made to reduce losses to the minimum figure. It was formerly the practice to instal the motor on the floor of the factory, but in modern installation it is found advantageous to locate the motor in a position level with the main shafting, the power saved by the superior drive obtained being considerable. Since the losses in bearings of the ordinary type are considerable, it is well worth while to go to the expense of ball bearings for shafting. This expense is certainly considerable, but experience has proved over and over again that the saving in power very soon justifies the initial outlay. The weight of the belts used also requires careful attention, particularly in the case of an old power plant being adapted for electric driving. In such a plant it will often be found that the existing belts are far heavier than are required for the electric drive. Such belts should be replaced by one of correct weight, or the loss of power will be considerable.

In deciding upon the number of machines to be driven by the various motors, there is another factor that will have to be considered. Since it is necessary in all industrial works to provide as far as possible against breakdown of the power supply with consequent stoppage of work, it follows that it is desirable to carry in stock spare motors and starting switches, so that any that fail may be immediately replaced. The number of spares will then depend upon the numbers of types and sizes of motors actually in use, the smaller this latter number being, the smaller the stock of spares required By so arranging the grouping of the machines that only a few sizes and types are in use, it is possible to provide a spare for every motor. This point was largely overlooked in many of the earlier uses of electricity for power purposes, in which factories it was no uncommon thing to find that in a total of 30 motors there were no less than 20 different sizes and makes. In such a case it would hardly be feasible to provide 20 spare motors, starters, and other accessories, with the result that if a breakown occured great delay was occasioned in getting the machines running again. In an ordinary installation of 30 motors, it is usually possible to use no more than three sizes, when the provision of a spare motor and starter of each size is quite practicable, and enables a stoppage due to a breakdown to be rectified in about half-an-hour by changing the defective motor, repairs being carried out at leisure in the repair shop.

In the selection of a motor there are innumerable points that might claim attention, and the best assurance that can be obtained of general suitability of design is by purchasing from a firm of sound reputation. There are, however, a few features of great importance which can easily be examined. The oil well of the motor bearings should be of ample capacity and should be painted internally, the covers being hinged and fitted with a spring to ensure their being kept closed. The overflow pipe should be of ample size. The brush holders should be of the box type, the brushes being provided with a flexible conductor to carry the current from the brush to the holder. The brush gear should be so designed that the brush holders can be easily taken off their spindles, while it should be possible to remove the whole of the brush gear without dismantling the machine, the brush rocker being made in two halves to allow of this being done. Terminals should be of robust construction and contained in a terminal box easily accessible. Separate terminals should be provided for the field connections, while particular attention should be paid to the connection between adjacent field coils. These should be made in suitable connectors, to allow of easy disconnection for testing, and they must, moreover, be strong and durable, or open circuits will soon give trouble.

It is now well recognised that the wiring from the point of supply to the motors should be of the best quality and workmanship. A fault on a wiring circuit is likely to cause greater delay than a motor breakdown if this fault cannot be immediately found, or temporary wires are not available. Wiring should be periodically tested in order that incipient faults may be located and repaired before actual breakdown.

HYDRO-ELECTRIC DEVELOPMENTS IN SPAIN.

The Permanent Spanish Electric Commission which was appointed in January, 1919, to study the "possibility and practicability of the construction by the State, directly or indirectly, of a national system for the distribution of electric current," has made public its findings in a pamphlet addressed to the Ministry of Public Works. The system as conceived by the Commission would be a series of transmission lines passing through, or near, all of the important consuming centres which are on the north or south coast, with radial lines to Madrid, which is practically in the centre of the country. Power would be generated at the larger waterfalls, and also at mines where coal of too low grade to be exploited commercially could be used to produce energy cheaply by being burned at the mine shaft. These steam centrals would be used principally during the droughts which occur at certain seasons in all parts of Spain, and in this manner there would be an abundance of power during the entire year.

Taking into consideration the waterfalls of more than 2,000 kws. (kilowatt = 1.34 horse-power), the

Commission states that there are available some 2,000,000 kws., located as follows:—

	Kilowatts.
Atlantic slope of Leon and Galicia	70,000
Asturias	40,000
Santander	30,000
Ebro, before reaching Saragossa	65,000
Rivers from the slopes of the Pyrenees	490,000
Ebro, from Saragossa to the Mediterranean	130,000
Duero in Spain	90,000
Duero on the Portuguese frontier	150,000
Tributaries of the Duero	50,000
Tagus	110,000
Tributaries of the Tagus	50,000
Guadiana	35,000
Guadalquivir and other Andalusian rivers	40,000
Jucar and Cabriel	90,000
Other rivers on Mediterranean slope	60,000
Various falls of minor importance	500,000

One of the greatest advantages to be derived from a national system, apart from the continuous supply of cheap power to all users, large and small, would be the unification of the frequency and voltage. The former is now standardised at 3-phase, 50 cycles, throughout Spain, and the latter would be regulated after more study of the needs of the principal industries. For the main branches of the transmission line it is recommended that the potential be not less 120,000 volts.

In estimating the cost of the lines, it is assumed that there will be 888 miles of wire, a cross-section of which will have an area of 50 square millimetres (a square millimetre = 0.0155 square inch) and 1,100 miles of wire with a cross-sectional area of 100 square millimetres. The lines will be in duplilate throughout, protected by a ground wire, and provided with four telephone circuits. The posts may be of concrete and steel, spaced at an average distance of 410 feet. The insulators considered best are those of the suspension type, six elements in series. With a line using 100-square-millimetre wire, the prospective cost per kilometre is divided as follows:—Eight iron columns of 800 kilos. (kilo = 2.2 pounds), erected, including the foundation. at one peseta per kilo., 6,400 pesetas; 48 series of insulators at 75 pesetas per series, 3,600 pesetas; 1,000 metres of grounding cable 10 millimetres in diameter, weighting 500 grams per metre, in place of 1,000 pesetas; six conductors of 100 square millimetres cross-sectional area, weighting 5,400 kilos., at two pesetas per kilo., 10,800 pesetas; loss of 5 per cent for curves, joints, etc., 530 pesetas; protection and switching stations, 2,500 pesetas; and telephone line, 850 pesetas.

The foregoing amounts added give an average cost per kilometre of 25,690 pesetas, which certain other expenditures bring to 30,000 pesetas, or 42,900,000 pesetas for the 1,430 kilometres of line with 100-square-millimetre wire. To this figure should be added the costs of the lines of 75 and 50-square-millimetre wires; namely 1,200 kilometres at 27,300 pesetas per kilometre, or 32,760,000 pesetas, and 1,770 kilometres at 24,600 pesetas per kilometre or 43,542,000 pesetas. This makes a total of 119,202,000 pesetas which is rounded off to a grand total of 130,000,000 pesetas for the entire network completed and made ready for operation.

The State will entrust to a Commission of experts, experienced in hydro-electric problems and in the transportation of high power for long distances, the study of a final general system to be constructed by the Government. This Commission will be organised with the permanent Spanish Electric Commission as a basis, and its membership will be completed by the representation of such interests as the Ministry of Public Works considers should be taken into consideration. In conjunction with hydro-electric power, to which preference will always naturally be given, a study will be made of the utilisation of fuel of an inferior quality and low price, or of coal which occurs in regions incapable of being exploited on account of their great distances from consuming centres.

THE SMALL SHOP.

The present dearth and high price of machine tools is having one very obvious effect, it is giving some ingenious individuals furiously to think, the outcome of which thought when expressed in material terms is of no small interest.

Before embarking on large expenditure, close attention is being given as to whether the tools already in existence cannot be speeded up either directly or indirectly. A larger pulley on the line shaft or the provision of easier handling facilities or simple jigs are all assisting output.

Further than this, in place of discarding antique tools, these are being in some cases refitted at home, and here and there by alteration are being put to entirely new uses. One instance concerns a discarded 10 inch lathe which has had the bed severed at the gap, the fast headstock placed square to the centre of the bed, the latter made to elevate by mounting on a couple of standard castings (defective for their legitimate use by the way), and quite an effective milling and boring machine has been extemporised. It is doing good work of engine character although it looks rather queer at first sight.

The same small shop man is also rigging up a pit with a couple of pedestals, and by using another lathe headstock is going to mill some large jobs instead of buying a large lathe to turn them.

Doubtless the same ingenuity might have been applied if prices were normal, but present costs certainly enhance the value of such mechanical application. The same individual, who is making strenuous efforts to increase output without increasing plant, complains of weak live spindles and tailstocks; he is discovering the limitations of his existing machine tools when subject to overload conditions.

In the same shop, a home-made drop stamp is doing yeoman service in forging levers; it is slower than a steam or pneumatic hammer but it allows first-class work at a minimum cost for plant; and this was the immediate issue when it was installed. Some very good stampings have been made in quantity with the aid of a home-made furnace.

The responsible man is, of course, part owner, but this does not do away with either the moral or the merit evinced. There is an old proverb about cutting a coat according to the cloth, and the writer can vouch for the workmanship of the firm's commercial product.

DINNER OF THE DIESEL ENGINE USERS' ASSOCIATION.

Proposal to form a Research Association for Fuel Oils.

Members and others interested in the work of the Diesel Engine Users' Association met at a dinner at the Connaught Rooms, London, on 23rd October.

In proposing the toast of the "Diesel Engine Users' Association," Sir Frank Heath, K.C.B., Secretary to the Department of Scientific and Industrial Research, referred to the proposal that an Association should be formed for carrying out research work on liquid fuels for Diesel and semi-Diesel oil engines under the Government scheme for industrial research. He understood the whole question had been discussed and considered at the meeting of the Diesel Engine Users' Association which had been held that day.

Sir Frank Heath emphasised the fact that this was an Association of users. He thought that in dealing with the fuel problem, if the user and the fuel producer could combine and obtain an interchange of knowledge, then of necessity success would be far more easily attainable. He noted with approval that it was the intention of the Association to invite the co-operation of fuel producers and oil engine makers in connection with research work for fuel oils best suited to their purpose. He assured the members that his Department of the Government would be pleased to assist them in this matter in a substantial way. He referred to the fact that the Fuel Research Board were now working on the question of treating coal in such a manner as to produce a fuel oil suitable for use in internal-combustion engines, and he thought that the work which they were carrying out ought to be of very great assistance to the Diesel Engine Users' Association.

Mr. Napier Prentice, A.I.E.E., President, responded for the Association.

Major-General Sir G. K. Scott Moncrieff, K.C.B., K.C.M.G., C.I.E., referred to the possibilities of oil production from the shale deposits in West Norfolk.

Admiral Sir Edmond Slade, K.C.I.E., K.C.V.O., referred to the large area of oil-bearing country in Persia as equivalent in extent to the whole of France and Germany together, and generally to the possibilities of oil production in the British Empire. He considered that the absolute importance of economy in consumption would necessarily lead to a great extension of the use of internal-combustion engines in maritime practice.

Mr. J. L. Major spoke on the subject of tar oils, and referred to the large demand for creosote for other than fuel purposes.

Mr. Charles Day and Mr. Guy Petter gave some interesting information concerning the Diesel and semi-Diesel engine industries, and among others who attended the dinner were Sir George Beilby, F.R.S., Mr. Alexander Richardson, M.P., Mr. C. H. Wordingham, C.B.E., Mr. Michael Longridge, Mr. John Belliss, Dr. W. R. Ormandy, Professor J. S. S. Brame, Mr. E. H. Cunningham Craig, Mr. H. W. Robinson, etc.

A NEW COMPANY.

In consequence of developments in export trade, the Snowdrift Trading Co. Ltd. has been formed to specialise in this business and in import. They have acquired the sole general European representation, and certain other business of Snowdon, Sons and Co. Ltd., also the business and agencies hitherto held by Mr. William Allan, of Allan and Grant, Moscow. Their arrangement with Messrs. Snowdon will be to the advantage of their agents and clients, and not prejudicial in any way. They are prepared to act as buying agents for all parts of the world, which the long experience of the Directors and staff particularly qualifies them for. Mr. John Snowdon, who continues to be chairman of Snowdon, Sons and Co. Ltd., also holding that position in this company, has long experience of export trade. He has travelled extensively in various parts of the world, gaining much useful information. Mr. William Allan's connection with textile trades in Russia, the Continent, and England places the company in an advantageous position for the supply of machinery and all equipment for mills, etc. Mr. Harry Snowdon, being an electrical engineer, with English and American experience, will be able to buy to advantage, and advise on electrical matters. The secretary and manager, Mr. J. A. Groes, who for many years held an important position in the export department of Messrs. Morgan, Gellibrand and Co., and latterly with Messrs. Blix and Co., will be of invaluable assistance to the company. As soon as expedient, the Moscow and Petrograd offices will be reopened. It is also intended to establish offices in Paris, Stockholm, etc.

Letters to the Editor.

PROPOSED LEVY ON CAPITAL INCREASES DURING THE WAR.

To the Editors of "The Industrial Engineer."

Sirs,—Schemes are constantly being propounded for the reduction of our enormous national indebtedness, unfortunately augmented as a result of mismanagement, waste, and inefficiency, which seem still to go on; but little attention seems to be given to the difficulties attending the economically practical aspect of any of them.

The original proposition of a general levy on Capital has, in the opinion of many who have given real consideration to it, been dismissed as wholly unpractical.

A new proposal has now been made, to conscript Capital Increases during the war. There is no doubt that investigation might prove that some profits have been made by realising assets at greatly enhanced prices due to war conditions, and that these profits may not have come within the range of the Excess Profits Duty. The extra profits resulting from ordinary trading are, however, in a different category.

Since the introduction of the Excess Profits Duty, £800,000,000, or thereabouts, seems to be the gross sum liable under that duty. Out of this total, rates varying from 50 per cent to 80 per cent have been paid over to the Government, amounting probably to £500,000,000, and the remainder, left in the hands of the traders, has been subject to Income Tax claims of nearly 30 per cent.

"Excess Profits" have largely been made by the appreciation of stocks and the raising of the money value of commodities, and it cannot be overlooked that a considerable part of them may be lost when, sooner or later, the fall in prices comes. Then again, the profits that have been made in ordinary trading have been essential in most businesses, owing to the large extra capital required for carrying them on. The purchasing power of money has depreciated by more than one-half, and an increase in the return on capital becomes as necessary as is the increase in the wages of the workers due to the increased cost of living. The position of people with fixed incomes, or of those who are living upon their accumulated savings, is lamentable. Not only are their incomes reduced by war taxation, but the purchasing power of what is left is reduced by one-half, and the realisable value of their capital has in many cases also fallen considerably.

Clear thinking is a great national asset, and should be possessed by those who venture to propound such schemes either in Parliament or in the press. All the practical results of their working should be seen from the beginning.

I hold that our only chance of meeting our national indebtedness is in the development of our Industry and Commerce to the utmost; to get all the wheels of industry started again as speedily as possible; for I am convinced that the adoption of the proposals mentioned would produce quite the opposite effect to that intended.

I am, yours faithfully,

Charles W. Macara.

Manchester, October 22nd, 1919.

Lantern Slides for Lectures. Messrs. Ed. Bennis and Co. Ltd. inform us that they have a large number of lantern slides dealing with the development and present practice of automatic stokers, coal elevators, and conveyors, etc., which they will be pleased to lend to any responsible engineer for lecture purposes. A list of the slides and particulars of their subject matter can be obtained on request. Applications for slides should be made as far in advance of the lecture as possible, and should be addressed to the firm at 28, Victoria Street, London, S.W.1.

Oil in Queensland.—A geological expert writing in Australia has recently vouchsafed the following opinion regarding the possibility of further oil discoveries in Queensland. He says, "While in Roma I examined the bore there, and my opinion is that they will not obtain oil in payable quantities. If it is ever got in Queensland, it will be several hundred miles away north-east from Roma. I am of opinion that after striking the gas at Roma they will get into a swelling formation, which will hold the casing, and when another layer is used it will very soon catch it and hold it as well. If ever they are able to get down to 6,000 ft., it will be owing to the exceptional qualities and knowledge possessed by the manager in charge of the plant."

New Companies Registered.

Bucks Mechanical Transport Ltd. (158,920).- Registered September 19th. Capital £10,000, £1 shares. Agreement with H. J. Wood, A. H. Cubitt, and B. M. Williams. Minimum cash subscription, 7 shares. Directors : H. J. Wood, A. H. Cubitt, and B. M. Williams. Secretary : H. J. Wood. Solicitor : W. J. Standring, Amersham.

Gilbert Campling Ltd. (159,000).—Registered September 22nd. Capital £200,000, £1 shares. To enter into agreements with Gilbert Campling Ltd. (incorporated in 1919), and its liquidator, and the Selsdon Aero Engineering Co. Ltd. and its liquidator. Manufacturers of and dealers in motor vehicles, aeroplanes, motor and aeroplane accessories, etc. Minimum cash subscription, 7 shares. The subscribers are to appoint the first directors. Solicitors : Ashurst, Morris, Crisp and Co., 17, Throgmorton Avenue, E.C.

Leyland Motors Ltd. (159,177).—Registered September 28th. Capital £1,850,000, £1 shares (200.000 6 per cent cumulative preference, 750.000 7½ per cent cumulative preference, and 900,000 ordinary). To take over the business of manufacturers of motor wagons, lorries, vans, etc., carried on by Leyland Motors (1914) Ltd., at Leyland, Lancashire. Agreement with Leyland Motors (1914) Ltd. and its liquidator. First directors : G. Lee Bevan, P. Haig-Thomas, C. G. Hatry, C. B. Nixon, H. Spurrier, A. Spurrier and W. J. Thorold. H. Spurrier and A. Spurrier may retain office while holding £1,000 shares each. Minimum cash subscription. 7 shares. Registered office : 6, Austin Friars, E.C.

Patent Castings Co. Ltd. (158,860).—Registered September 17th. Capital £100.000, £1 shares. To take over the business of the Patent Diecastings Syndicate Ltd., incorporated in 1909. Minimum cash subscription, 7 shares. First directors : C. L. Simpson and H. Hetherington. Registered office : 64, Strode Road, Willesden Green, N.W.

Pullinger Engineering Co. Ltd. (159,013). Registered September 22nd. Capital £250,000, £1 shares. Manufacturers and dealers in automobiles and other vehicles, etc., and to adopt an agreement with the Vernon Promoting Syndicate Ltd., for the purchase of the business of Pullinger and Co., of 22, Latona Road, Peckham, S.E., and of the Inwood Motor and Engineering Co. Ltd., of 92, 96, and 98, Upper Richmond Road, Putney, S.W. Minimum cash subscription, 7 shares. The first directors are A. H. J. Pullinger, C. A. Rawlings, Lt.-Col. C. C. Vaid, Capt. T. E. Hesketh, G. Brunelli, Major E. A. W. Maude, and H. W. Candy. Registered office : Giltspur Chambers, 52, Holborn Viaduct, E.C.

Drayton Iron and Steel Co Ltd. (159,191).—Private company. Registered September 29th. Capital £850,000, £1 shares (400,000 preference). To acquire, hold, and deal with debentures, shares, and securities of any company concerned with the searching for, getting, working, raising and making merchantable, selling and dealing in ironstone, limestone, iron, coal, brick-earth, bricks and other metals, minerals and substances, and the manufacture and sale of patent fuel ; to carry on the business of ironmasters, steel makers and converters, colliery proprietors, coke manufacturers, etc., and to enter into agreements between C. Kidner, on behalf of shareholders of the Islip Iron Co. Ltd., of the first part, A. C. J. Wall, on behalf of shareholders of the Bloxham and Whitston Ironstone Co. Ltd., of the second part, and the Drayton Iron and Steel Co. of the third part. The first directors are not named. Registered office : 9, Gt. St. Helens, E.C.

Lightning Construction Co. Ltd. (159,109). Private company. Registered September 25th. Capital £50,000, in 12,500 10 per cent preference ordinary and 35,000 ordinary shares of £1 and 50,000 shares of 1s. each. To acquire the right and interests of P. L. G. Johnson and the Lightning Construction Co. in an invention for improvements in or relating to reinforced concrete building construction. Joint managing directors : P. L. G. Johnson and W. L. Martin and one other to be appointed by them. Solicitor : C. Crowther, 23, Abingdon Street, S.W. Registered by Jordan and Sons Ltd., 116-17, Chancery Lane, W.C.

Reading's Patents Ltd. (159,046). Private company. Registered September 23rd. Capital £1,000, £1 shares. To acquire from H. C. Reading certain inventions relating to improvements in internal combustion engines, power transmission mechanism suitable for automobiles, etc., and variable speed gear mechanism, etc. Directors : H. C. Reading, W. Dawson, G. Dawson, S. O. H. Dawson, G. A. Blackburn, W. Dimbleby, and J. W. Bramham (all permanent). Secretary : G. Dawson. Registered office : Lancashire and Yorkshire Bank Chambers, Market Place, Dewsbury.

Smithbrook Engineering Co. Ltd. (158,984).—Private company. Registered September 20th, by Jordan and Sons Ltd., 116-17, Chancery Lane, W.C. Capital £1,000, £5 shares. Mechanical, constructional, motor and general engineers, etc. The first directors are G. Ibbetson, M. Ibbetson, O. H. Harris, and K. N. Harris. Secretary : M. Ibbetson. Registered office : Smithbrook Engineering Works, Market Street, Chapel-en-le-Frith, Derby.

The Agricultural and General Engineers Ltd.—We hear of one of the largest amalgamations which has latterly taken place in the engineering trade. The firms that have amalgamated are : Messrs. Aveling and Porter Ltd., of Rochester ; Messrs. E. H. Bentall and Co. Ltd., of Heybridge ; Messrs Blackstone and Co. Ltd., of Stamford ; Messrs. Richard Garrett and Sons Ltd., of Leiston ; and Messrs. James and Frederick Howard Ltd., of Bedford. These names are all household words in the engineering industry of the country, and most of them have been established well over 100 years. The amalgamation will be known as "The Agricultural and General Engineers Ltd.," with a capital of three millions sterling, formed with a view of employing a large amount of British labour on mass productions. The firms entering the amalgamation will in no sense lose their identity, nor is the management to be changed ; the whole object of the amalgamation being massed production and efficient selling organisation. The various works will specialise in their chief products. They will be greatly extended, and already a great amount of this work and the purchase of new tools has been undertaken. The Head Offices of the Amalgamation will be at Central House, Kingsway, London, but until the Government Department, which is now in possession of Central House, have removed (which will be in the course of the next two months) the temporary offices are at 50, Pall Mall, London, S.W.1.

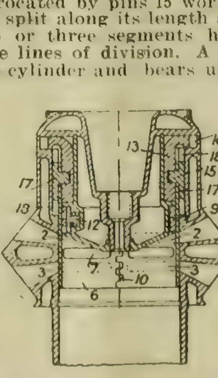
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

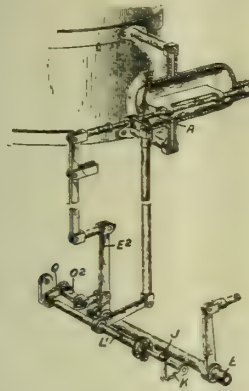
121,782.—H. J. Howard and J. S. Howard, 59, Filton Avenue, Gloucester Road, Bristol. December 28th, 1917. A slide valve 6 having a port 7 which registers alternately with inlet and exhaust ports 2, 3 is reciprocated by pins 15 working in a grooved cam 13. The valve may be split along its length at one side only or it may be formed in two or three segments having tongue and groove joints 10 along the lines of division. A packing ring 9 is located in the head of the cylinder and bears upon the inner face of the



valve, leakage at the joint being prevented by a spring-pressed member 12, or by a second ring mounted inside the main ring 9. Rotation of the valve is obviated by projections 17 thereon sliding in grooves 18 in the cylinder walls. The cam is roated through a toothed ring 16 which may gear with a ring on an adjoining cam or with a driven pinion. If desired, the cam may surround the valve, and the inlet and exhaust ports may be disposed on opposite sides of the cylinder in one or more rows. One row may be uncovered by the edge of the valve. The cam may rotate at one-half, one-third, or one-sixth the speed of the crankshaft, and it may be formed as a rib having rollers engaging both sides of it. The valve may be actuated in one direction by a cam and in the other direction by a spring.

STEAM GENERATORS.

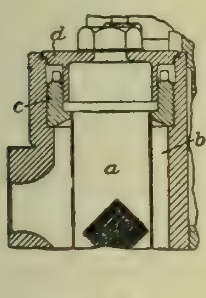
121,799.—T. CLARKSON, Woodlands, Galleywood, Chelmsford, Essex.—December 31st, 1917.—When the boiler water level rises above the normal, the feed pump suction valve, which normally is free to lift and fall back in the usual manner, is held off its seat by mechanism under the control of a float on the boiler. The suction valve J is held off its seat by a lever K on a shaft



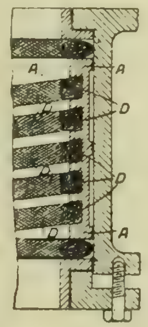
L1 so connected to the float spindle A that it is rocked by the rise and fall of the float. The shaft has imparted to it a constant reciprocating movement to prevent it from sticking in the bearings. The movement is imparted through levers O, O2, E2 by a rocking shaft E. The float spindle is also so connected to the rocking shaft that it is constantly reciprocated. Specifications 18,658, 1903, and 108,507 are referred to.

PUMP STRAINERS.

121,864.—W. E. SAVERY, Ivy Bank, Middleton Hall Road, King's Norton, Birmingham.—March 2nd, 1918.—A pump strainer *a* is mechanically connected to its receptacle *b*, as by a screw, threaded collar *c*, and the closing cap *d* of the receptacle is mechanically connected to the strainer, as by a screw thread, so that the opening through which the strainer is inserted cannot be closed until the strainer is in place.



Patent 121,864.



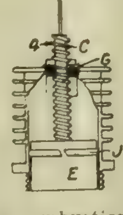
Patent 121,868

STUFFING-BOXES.

121,868.—SIR G. F. SLEIGHT, The Hall, Weelsby, near Grimsby, Lincolnshire.—March 8th, 1918.—Asbestos or similar soft packing D is arranged in helical or annular grooves in a cylindrical casing A of brass or other metal or alloy, or the casing may have an anti-friction metal lining in which the grooves are formed. The casing may be in halves, the abutting faces of which have interengaging pins and recesses and may form lap joints with one another. The grooves in the two halves may be out of register.

INTERNAL-COMBUSTION ENGINES.

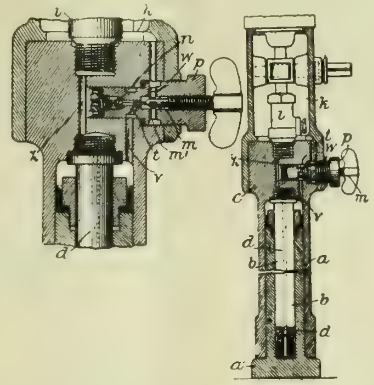
121,876.—N. SMITH, 238, Great Western Street, Moss Side, Manchester.—March 18th, 1918.—A small cylinder E is screwed into some



convenient aperture in the combustion chamber. Its piston J is adjusted by a quick-threaded screw C working in a nut G. The movement of the piston is limited by a set screw 4.

LIFTING-JACKS.

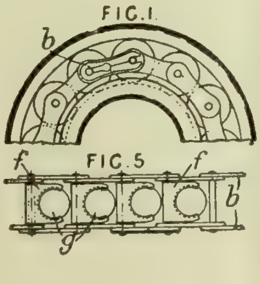
121,860 TANGYES LTD., Cornwall Works, Smethwick, and E. JOHNSON, 65, Wellington Road, Bilston, both in Staffordshire. February 27th, 1918.—Hydraulic jacks are provided with two concentric rams and cylinders and valve mechanism whereby water can be directed into one only of the cylinders to effect a relatively rapid movement of the head of the jack or can be forced into both cylinders when a slow movement is desired. The hollow ram *a* is integral with the foot *a*1 and forms the cylinder for the other ram *b* which has an axial passage *d* and is screwed to the body *c*. The flow of the water pumped from the cistern *k* to the rams by the pump *i* is controlled by a stop valve *m* and spring-pressed valve *n* fitted in a tubular valve body *p*. The valve *n* is



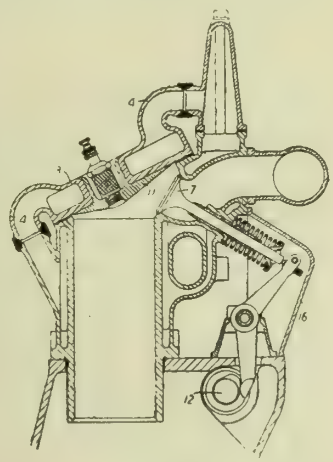
opened by an extension *m*1 on the inner end of the valve *m* when the latter is closed. Passages *t*, *w* in the valve body permit communication between the central passage and passages leading to the ram *a* and cistern *k* respectively. When the valve *n* is closed, the water pumped by the pump *i* passes only to the ram *b* through the passages *z*, *d*, but when the valve *n* is open and the valve *m* closed a part of the water passes to the ram *a* through the central passage in the valve body and the passages *t*, *v*.

BEARINGS.

121,909.—F. BRIERLEY, Grand Hotel, Manchester.—June 6th, 1918.—Bearing rollers and balls are spaced by endless chains consisting of links connecting the ends of spindles or hollow hubs extending through the rollers, or through pockets holding the balls, the rollers or balls being held against end movement by shoulders on the race rings. One or more of the links *b*, Fig. 1, may be detachable. In a bearing having two rows of rollers, each spindle may extend through two rollers, or separate chains may be used. One or both of the races may have ribs separating the rows of rollers. The rollers may be cylindrical or barrel-shaped and one of the races may be curved to render the bearing self-aligning. Fig. 5 shows a number of pockets *f* holding balls *g* connected by endless chains *b*.



Patent 121,909.



Patent 121,977.

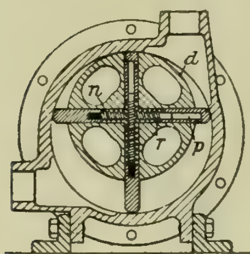
INTERNAL-COMBUSTION ENGINES.

121,977.—S. S. GUY, Woodview, Finchfield, Wolverhampton.—Oct. 8th, 1917.—The valves 7 are situated in the cylinder wall near the cylinder head, their axes being inclined to that of the cylinder. The cover 3 is on the inclined end of the cylinder through which the valves may be removed. The cover is hollow and connected through branches 4 with the cylinder jacket; it may be fitted with a plate 11 for reducing the volume of the clearance space. The valve gear is enclosed in a lateral casing 16; the cams 12 may act directly on the valves.

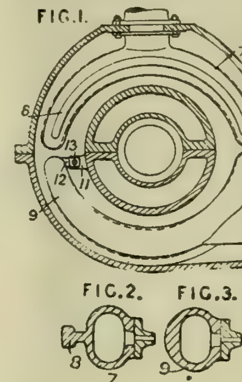
ROTARY ENGINES AND PUMPS.

121,985.—FLETCHER, RUSSELL AND CO., J. H. SINGLETON, and C. YOUNG, Palatine Works, Warrington, Lancashire.—Dec. 3rd, 1917.— In rotary engines, pumps, etc., of the kind having pairs of diametrically-opposite sliding spring-pressed vanes, guided rods *n*, secured to one vane of each pair, extend across the drum *d* and

work freely in holes p in the complementary vane, and the springs r are mounted on the rods. The rods may pass through some of the material of the drum, or the slots in which the vanes work may extend completely across the drum, the sections of the drum then being connected by end discs.



Patent 121,985.



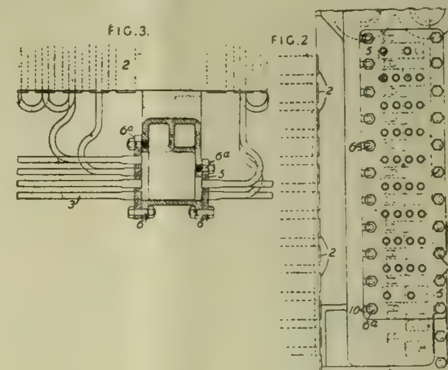
Patent 122,033.

TURBINES.

122,003.—H. L. GUY, Trevethin, Albany Road, Victoria Park, Manchester.—Jan. 4th, 1918.—In nozzle boxes 7, 9 of the kind described in Specifications 105,370, 115,666, and 116,347, the guide device for permiting movement of the box under expansion to take place only in a plane perpendicular to the turbine axis may be dispensed with by providing the box with a stiffening rib or ribs 8, Figs. 1 and 2, or by thickenning its walls, Fig. 3. at such parts that the box when in position has a greater flexibility in the permissible direction. If desired, a pin 13 engaging lugs 11, 12 on the turbine casing and the nozzle box may be provided to restrain movement in the axial direction.

STEAM-SUPERHEATERS.

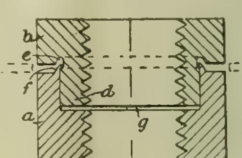
122,068.—SWAN, HUNTER, AND WIGHAM RICHARDSON, Neptune Works, Walker, and A. MCCLELLAND, Ferndale, Midhurst Road, Benton, both in Newcastle-on-Tyne.—Feb 27th, 1918.—In order that a number or all of the superheating elements inserted in a nest of smoke-tubes may be withdrawn simultaneously, the elements are expanded into a common plate secured to the side of the header by screw devices, the side of the header having openings into the the saturated and superheated steam chambers of the header. The plates 5 on the side of a header of the kind described in Specification 9,098/12 carry all the elements 3 in the nests of smoke-tubes 2 on each side of the heater. The plates are secured by nuts and bolts 6, and by screwed studs and nuts 6a.



slots 10 in the edges of the plates allowing them to be slid beneath the nuts and into the engagement with the studs. In a modification, the elements in only two rows of smoke-tubes are secured to a common plate. The elements may be of the kind described in Specification 107,394.

LOCKING NUTS.

122,272.—S J. ROSS, 117, Leadenhall Street, London.—Jan. 28th, 1918.—In a nut-lock comprising two nuts, one of which has an eccentric spigot d engaging a socket in the other, a gap g is left between the nuts equal to a fraction of the pitch so that.



when the part b is turned for locking, it will jam against the part a in addition to binding on the threads by its eccentric movement. The threaded bore is eccentric to the spigot d, which is concentric with the exterior of the nuts. The two parts a, b are permanently keyed together by a tapered lip f pressed into a groove e.

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CONTENTS.

EDITORIAL.

THE SIZE OF MEN.

THERE is a sense in which the relative values of men and their work may be compared, for it is certain that while the man himself has a great deal to do with the quality of his work, his work reacts equally upon the man. Indeed, in a great many instances it is impossible to separate the one from the other. At the same time it would be foolish to assume that a particular individual is essential to render certain work possible, yet it is difficult to conceive some most important activities apart from specified men. It was, at all events, the belief of one great thinker that history was the biography of the world's great men. Like most phrases of the kind, the saying is true up to a point, and although it is accurate only in a partial and limited sense, it has value in the assessment of past endeavour.

It is perhaps too little realised that what applies distinctively in the larger issue has a real bearing upon the small; while history is made by the superman, the essential work of the world rests in exactly the same manner upon the infra-man; the unregarded unit in business and production is in his own limited field just as important. The realisation of the foregoing statement is the belief which underlies all democratic control. In other words, the plain commonsense man's value and collective activity underpin everything else.

The mechanic, the operative, the man in the street and shop, the manual worker and the productive unit exercising thought are quite as essential as the directive mind in industry. Though the dislocation involved in any substitution is less at lower levels, it does involve dislocation nevertheless. The skeleton framework of organisation cannot afford to minimise the importance of the minor executive; in fact, he is often more indispensable than many higher up the scale.

In this matter of the assessment of men, one striking fact comes to notice and it has a bearing upon the subject which cannot be avoided; some men are larger than their job, while the majority are smaller. The question of value in any position depends almost entirely upon this fact, and in any industrial connection the human material separates into two distinct categories due to this cause. It is upon relative value in terms of the job that distinction is found, not in the size of the job itself. Competency in a superlative sense is uncommon at any level; it is better to be competent a step lower in rank and position, than labouring under great difficulties to be found wanting in a higher sphere.

One of the chief qualifications of administrative ability is the power to recognise the able man lower down: failure to do this involves a loss none the less real because it is latent; real ability is quick to recognise talent elsewhere, for relationship is common where there is instinctive understanding. Not that the most ambitious are the most able, though a difference in potential usually manifests itself by some means or other. The best material for a possible future executive is perhaps the man who does his best working independently, and whom close supervision irritates the most. That man, as a rule, is larger than his job.

There is small question but that the selection and grading of human material is of even greater importance than the selection and determination of actual material. A really first-class organisation means a staff every man of which is competent to step up at short notice; one imperfect tooth in the

machine causes disturbance far greater than its intrinsic importance seems to justify.

There is a peculiar pleasure to the really competent in the acceptance of responsibility irrespective of the reward at stake, it is the irresolute who shrink from decision. The point is that in every minor position there is opportunity to prove merit, and outstanding competence is by no means hard to recognise by an able superior; indeed, if he is unable to recognise ability, he is himself wanting in the chief fundamental in the management of men.

To the ambitious man lower down, desirous of the privilege of a larger sphere, there is only one word of advice to be tendered, "Be larger than your present job." Qualification may not bring instantaneous promotion; it has, however, its own satisfaction; and persistent endeavour backed by a desire for service, together with real endeavour and ability, will in the long run secure at least some measure of success.

THE OPERATION OF DIRECT-CURRENT ELECTRIC MOTORS.

By E. Austin.

Selecting the Motor.

One of the most important matters to be considered when installing direct-current electric motors in iron and steel works, at collieries and other places, is the kind of load with which individual motors have to deal. There are three kinds of direct-current motors—shunt, series, and compound motors—each having different characteristics, and the importance of selecting the right type of motor for given conditions cannot be emphasised too strongly.

A Shunt-Wound Motor.

The shunt-wound direct-current motor is a machine having fine wire high-resistance coils on its field magnets, all the coils being connected in series and joined across the brushes. Such a motor behaves very much in the same way as a steam engine with a good governor; that is to say, it tends to run at constant speed at all loads and has no tendency to "race" even when all the load is thrown off it. This is due to the fact that the small current flowing in the shunt coils on the poles is independent of the load, but if the current flowing in the field coils be reduced by inserting resistance in the field circuit by means of a shunt regulator connected in the field circuit, as shown in Fig. 1, the speed can be increased above the normal value. The permissible increase in speed is a matter of design, and if it is desired to vary the speed of a motor by inserting resistance in the field circuit the speed variation necessary should be specified when purchasing the motor. When starting variable speed motors great care must be exercised to see that all the shunt resistance is cut out of the field circuit before current is switched on to the armature, for otherwise the magnetic field will be weakened and the machine will draw a starting current much in excess of the normal starting current, and the torque will be poor. For driving machines that are fairly easily started, and which are not subjected to sudden and frequent heavy overloads, shunt motors are suitable, but on no account must they be used for driving machines fitted with flywheels or machines that are different to set in motion. Without any special governing device the shunt motor runs at practically the same speed at all loads, and is used extensively in many industrial establishments.

A Series Motor.

A series motor having a thick wire low-resistance winding on its poles and connected in series with the armature behaves quite differently to a shunt-wound motor. Instead of running at a constant speed at all loads, as the load increases the speed decreases and the torque becomes greater. Hence, without any hand regulation, the motor automatically adapts itself to the work it is called upon to perform. When the main current is doubled, the torque is considerably more than doubled, for not only is the armature current doubled, but the magnetic field is also increased, owing to the fact that the main current passes round the field magnetos on its way to the armature. Were it not for the fact that after a certain point the iron in a motor becomes saturated, the torque of a series-wound machine would always vary directly as the square of the current, and if the main working current were

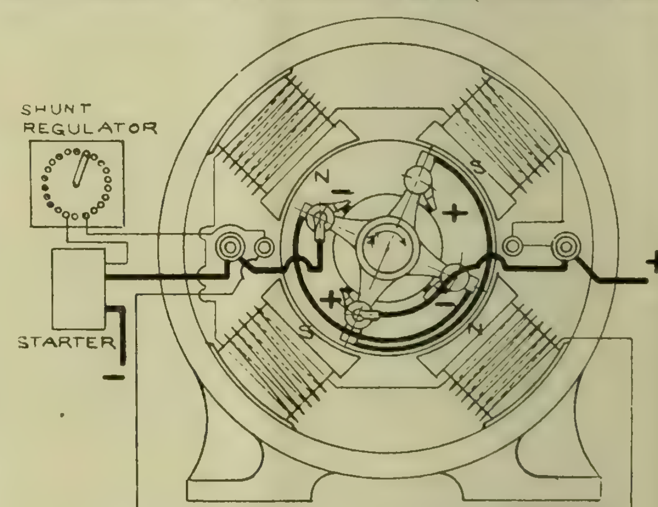


Fig. 1.—The Connections for a Shunt-wound Motor with a Shunt Regulator in the Field Circuit.

doubled the motor would develop four times its original torque. Obviously, twice the original current cannot under any circumstances make the motor develop more than twice its original amount of power, from which it follows that with twice the original current the motor will run at half its original speed. Series motors should never be used when there is a liability of all the load being suddenly removed, for the speed of a series motor under no load conditions is liable to attain an excessive and dangerous value. For direct coupled fans working against varying pressures series motors offer advantage, as the drop in speed when the load increases (through the air pressure being reduced) has the effect of eliminating the heavy overload which would occur with a constant speed shunt motor. Series motors are used mainly for driving winches and cranes, and for traction and intermittent work generally.

A Compound-Wound Motor.

The compound-wound motor is a series and shunt motor combined; that is to say, in addition to

having a fine wire winding on its poles, it also has a thick wire winding connected in series with the armature, as shown in Fig. 2. A motor of this type possesses the advantage of being capable of exerting a very poweful torque, whilst unlike the series motor it will not "race" if suddenly relieved of its load. The more series turns there are on the field magnets the easier will the machine start against heavy loads, and the greater will be the speed reduction between no load and full load, for if the main current flows round the field magnets in the same direction as the current in the fine wire winding, it is obvious that the heavier the load the greater is the magnetic effect of the field magnets. Compound motors can withstand heavy overloads much better than shunt motors, and are largely used for starting machines involving the acceleration of heavy masses.

Motor Troubles.

Whilst troubles with direct-current motors are occasionally attributable to a machine being used that does not possess the correct characteristics, unsatisfactory operation is much more often attributable to the development of certain faults. For instance, if a motor sparks at the brushes and the windings overheat, it does not by any means follow that the machine is unsuitable for its work. It may be overloaded. Of course, a motor may easily develop more than its normal-rated power for short periods, but if a machine runs constantly overloaded excessive heating and sparking may result. Sparking may, however, be due to many causes, such as incorrect brush position, a rough or untrue commutator vibration, an unequal air gap between the armature and poles owing to wear on the bearings, a short circuit or open circuit in the armature windings, unequal distances between brushes of opposite polarity, too much or insufficient pressure on the brushes, flat places on the commutator, a short circuit or earth on the field windings, loose commutator bars or mica projecting above the commutator surface. Periodically, a clean rag moistened with a small quantity of vaseline should be applied to the commutator whilst it is revolving, with a view to keeping it bright and clean, and if it is found that the surface is becoming blackened as the result of sparking, it should be cleaned with a piece of fine sandpaper fastened to a small wooden block or special commutator cleaner, the sandpaper being applied to the surface of the commutator whilst the machine is at work. But if, as the result of excessive and prolonged sparking, the commutator has developed flat places, the armature should be removed from the motor, and the commutator turned or ground in a lathe.

Grinding a Commutator.

The practice of grinding a commutator is preferable to turning, for there is much less risk of dragging the copper across mica segments, and so causing short circuits. If, however, a grinding equipment is not available, the commutator may be turned with the aid of a sharp tool and afterwards polished with fine carborundum cloth. In turning a commutator it is best to take a number of light cuts, rather than one or two deep cuts, and whilst the turning is being done care should be exercised to avoid copper turnings finding their way into the armature windings. In any case, after a commutator has been turned the windings should be blown out with a pair of hand bellows or an electrically operated blower.

To Overcome Sparking at the Brushes.

A trouble that sometimes arises with direct current motors, and which invariably results in sparking at the brushes, is that the copper segments of the commutator wear away at a more rapid rate than the mica segments, the result being that the mica projects above the commutator surface. To overcome this trouble it is now common practice slightly to undercut the mica so that it is always a little below the commutator surface. In manufacturers' works the mica is usually undercut with the aid of an electrically operated tool specially designed for the purpose, but in the absence of such a tool the job may be done with a short length of hack saw mounted in a handle. It is to be distinctly understood, however, that the mica must only be undercut very slightly, and all traces of mica dust must be removed from the slots before the machine is put into operation. It is of little use dressing up a commutator if the brushes are not properly set after the job has been finished. If the brushes make imperfect contact with the commutator, or if the pressure on the brushes is too little or too great, sparking may occur at the outset, and instead of the commutator attaining a smooth and bright surface it will rapidly become rough and blackened. Sparking may arise owing to the brushes sticking in their holders, or as a result of the brushes having too much play. Brushes that fit too tightly in their holders are liable to stick and fail to make proper contact with the commutator, whilst if the brushes are too loose in their holders they are liable to shake and chatter, and in absence of flexible shunts for conducting the current from the brushes to their holders arcing is liable to occur between the brushes and the metal work. If the pressure put upon the brushes by the springs provided to maintain the brushes in contact with the commutator is too weak, the brushes may be thrown off the commutator intermittently. The correct brush pressure is best determined by experience, but in many cases it is about $1\frac{1}{2}$ lb. per square inch of contact surface. The pressure can be measured by a spring balance, the reading of the

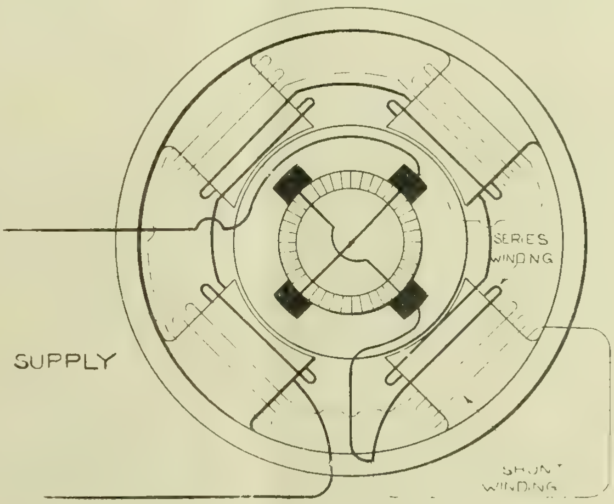


Fig. 2.—Compound-wound Motor.

balance being divided by the brush contact area in square inches.

Correct Spacing of the Brushes.

The correct spacing of the brushes around the commutator is important, for if the distances between rows of brushes on different spindles are unequal, local currents set up in the armature may result in heating and sparking. The brush spacing may be tested by counting the commutator segments between the brush tips, but a more convenient and perhaps more accurate scheme is to cut a strip of paper having the same length as the circumference of the commutator. This strip of paper is divided, with the aid of a pencil, into the same number of equal sections as there are sets of brushes, and by placing the paper under the brushes, the spacing can readily be adjusted by making the brush tips touch the pencil lines.

Fitting of New Brushes.

After a motor has been in use for some time the brushes wear away and new ones must be fitted. When the new brushes have been placed in the holders, they must be bedded down to conform with the curvature of the commutator. This can easily be done by placing a strip of sandpaper under the brushes with the rough surface in contact with the carbon, when, on pulling the sandpaper backwards and forwards whilst downward pressure is applied to the brushes, the lower surface will soon be made to assume the proper shape. After bedding the brushes in this manner, all traces of carbon dust must be removed from the windings and other parts of the motor before the machine is set to work. Great care must be taken to avoid grease and oil accumulating on the windings of electric motors. All the parts should in fact be kept perfectly clean, otherwise the insulation may quickly deteriorate.

(*To be continued.*)

JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By Herbert C. Armitage, of Birmingham, Associate Member.

(*Continued from page 57.*)

Tool Schemes for Various Outputs.

It is now proposed to show the different ways in which a component may be equipped with special tools, at the same time describing the various jigs in detail, showing the methods to be used. An auto-engine connecting-rod has been taken as the example. The author would much prefer to have used an aero-engine crank-shaft for this purpose, but the number of operations, and the consequent descriptive matter, would have been too great altogether for the scope of the Paper. The connecting-rod, however, is now of nearly as standardised a form as the crank-shaft, but unfortunately for the purpose in view it is a very straightforward piece of work.

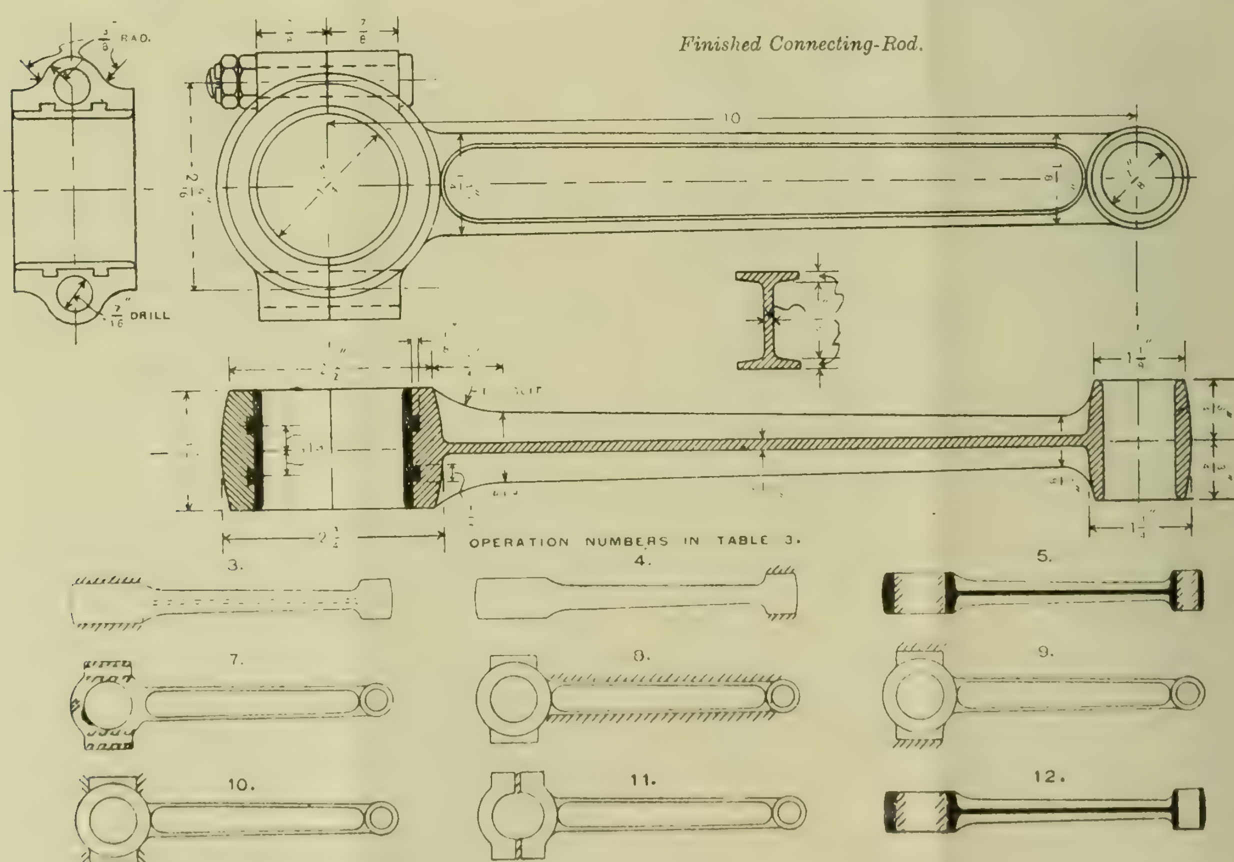


Fig. 4.—Finished Connecting-rod.

The considerations of the tools required for the

Table 3.

SCHEME FOR SMALL PRODUCTION.

Maximum Output = 6 per hour = 300 per week.

Operation No	Description of Operation	Fig. No. of Jig.	Time Required, Minutes per Piece.	Type of Machine.	No. of Machines.	Labour Cost per Piece.
1	Heat treatment of stamping	—				—
2	File burrs, &c.	—		—	—	—
3	Mill large end of rod	5	20	Horizontal Miller.	2	3·3
4	Mill small end of rod	6	12	,, ,,	1	0·2
5	Drill both holes	7	16	2-Spindle Drilling.	2	2·5
6	Broach small end	—	1	Broaching	1	0·1
7	Drill bolt holes and centre end of rod	8	15	Small Radial Drill.	2	2·5
8	Mill Sides of rod	—	25	Horizontal Miller.	2	4·2
9	Mill across bolt hole bosses	9	15	,, ,,	2	2·5
10	Mill across bolt faces	—	12	,, ,,	1	1·8
11	Part off the cap and fit bolts		12	,, ,,	1	1·8
12	Finish bore the large end	10	20	Turret Lathe.	2	3·3
13	Run white metal in large end	—		—	—	—
14	Finish bore white metal in large end	10	10	Turret Lathe.	1	1·7

manufacture of this component are divided under three headings as follows:—

Scheme 1.—A layout suitable for a contract of, say, 500-2,500 connecting-rods.

Scheme 2.—A layout suitable for a contract of, say, 2,500-50,000 connecting-rods.

Scheme 3.—A layout suitable for the permanent manufacture of the piece, or rather, a practically unlimited output in rate of manufacture and total quantity.

In each case the output will be estimated on the basis of the shortest operation, to obtain the most economical results, as mentioned previously in the Paper.

The connecting-rod and cap which are manufactured throughout together, are illustrated in Fig. 4, and produced from one stamping, so that the connecting-rod and cap are made together when forging. The manufacturing operations in the smallest basis of production are as shown in the layout in Table 3.

Jig for Milling Large End of Connecting-Rod (Fig. 5).

There are two connecting-rods placed in the jig at once, and a gang of four straddle mills are advanced across the work. The components are held at the bottom in fixed V-blocks, AA; and both are gripped together by a clamp B, which is given a wide range of movement by a cam C, pivoted on fixed stud D. The clamping action is transmitted to the work by two sliding V-blocks, and at the top of each is a small steel ball, to take the thrust. As it is most important that there should be no distortion of the connecting-rods in this operation, the other end is held vertically by means of a fixed V-block, which is as near a knife-edge in section as practicable, and a set-screw pushes a small boss against a rounded stud, thereby preserving the alignment of the connecting-rod sufficient for the next operation. Theoretically, the rod should have been "equalised" at this end, but if there is a moderate machining allowance for facing, it becomes an unnecessary refinement.

This operation is likely to give trouble if the cutters are not of a reasonable stiffness, and should

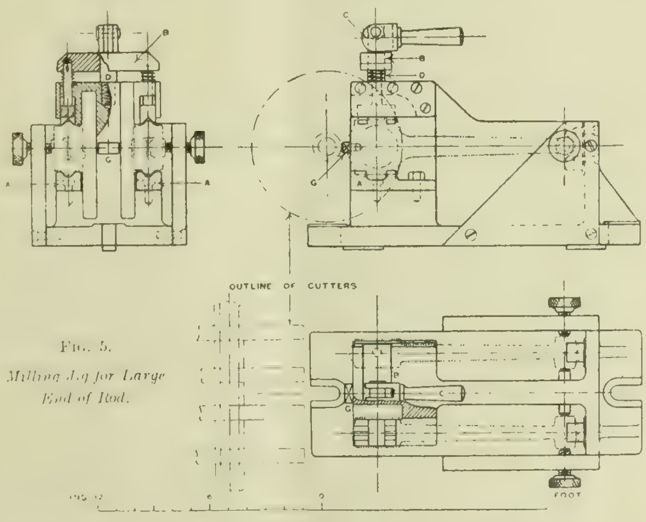


Fig. 5. *Milling Jig for Large End of Rod.*

Fig. 5.—Milling Jig for Large End of Rod.

there happen to be more metal to remove from one face of the connecting-rod than the other, the cutter is likely to spring, owing to its large diameter. To get the best results, there should be a close spacing of the cutter teeth—the opposite of the modern practice of giving cutters the fewest possible teeth. The reason is that the metal to be operated on is likely to prove hard. If there is a fairly large feed (say, 1 inch per minute) and wide spacing, there is

a substantial knock, due to the large shoulder of metal which will have fed up while the cutter tooth space has been passing. This knock is transmitted throughout the drilling machine, and causes the cutter teeth rapidly to become dull, as well as producing a poor finish on the work. The setting gauge G is made of hardened steel, and is about $\frac{30}{1000}$ less in width than the finished work. In setting up, a feeler is used $\frac{15}{1000}$ in. thick, and the cutters thereby spaced equally on each side of the gauge.

(To be continued.)

CHANCES FOR BRITISH GOODS ABROAD.

GERMANY wants, and intends, to do a big foreign trade—if she can. To this end information has been assiduously collected for some time past as to what goods are most wanted just now, and where. Below we give a résumé of the data obtained, which we have compiled from German sources. British engineering and other firms will do well to devote special attention to the hints given below; they should see to it that the gentle (?) Hun does not get his foot in first.

Of course, now that peace has again opened the doors to the world's trade, it is undoubtedly of the greatest importance for our export industry to know exactly just what goods are now scarce and badly wanted.

In Europe: Scandinavia, Switzerland, Holland, and Spain are all deprived of many things for which buyers are eagerly waiting. In Southern Spain there is now an especially pressing demand for mining plant, smelting and other machinery for treating metals, and every endeavour is to be made to replace the old primitive methods and machinery by modern processes and plant. There is also pressing inquiry for tinplate, railway accessories, motor cars, wire cables, typewriters, paints, colours, and paper.

In South Russia the following are urgently wanted: Agricultural machines and duplicate parts, tools, knives, ironmongery of all kinds, pig iron, and steel bars. For the past four years farmers have been quite unable to get any new seed drills, mowers, threshers, etc., whilst they have also been unable to repair those they already have.

Italy would be a prompt buyer of machine tools and industrial plant of all kinds, and plant for oil refining, bakers, confectioners, farmers, waterworks, electric centrals, textile firms, and also sewing machines for sewing sacks and bags.

Greece also needs a wide range of goods which it was quite impossible to import during the war. The Government has assisted in the opening of several new factories, but still only very little of the existing demand could be covered. Since the armistice, however, many Greek capitalists have been floating new factories, etc., for which material will be required, and although so far no new railways are planned, yet the lines already in existence need a lot of repairing. The Government also requires 10,000 ploughs, 200,000 ploughshares, 500 harrows, 200 mowing machines, 25 threshing machines, 100 presses, 500 sulphur sprayers, 600 vitriol sprayers for vines, and also petroleum and gas motors for marine and industrial uses.

In Turkey, after the war, Constantinople will undoubtedly become one of the largest trading centres of the Near East. Many goods are now required there, but more especially agricultural machinery and chemical products.

Mexico reports that in normal times there is a good and regular demand for rock drills, tool steel, sheet steel, iron plate, railway tools, and plant for working and crushing silver ores. There is, further, a great scarcity of ploughs, tractors, threshing machines, rice and coffee machines, and duplicate parts for same.

Argentina needs agricultural implements and machinery (especially at Rosario), electric articles, motor cars and wheel phonographs, sewing machines, varnishes, typewriters, windmills, locks, patent medicines, fountain pens, thermometers, galvanised and other wire, grain elevators, and kindred articles. In Buenos Aires there is a big opening for electric drying, cooking, ironing, and similar household appliances.

In Uruguay there is a big demand for iron plates for shipyards, iron and steel building materials, iron pipes, rails, and iron and steel ware of all kinds.

There is a steadily increasing demand in Bolivia for mining machinery, motor cars, paints, colours, and paper.

Of course, the above represent a mere fraction of the numerous articles that are now badly needed in all parts of the world, after nearly five years of war between the great nations of the world. British firms, therefore, should lose no time in being up and doing.

A METHOD OF CHECKING THE ALIGNMENT OF DIESEL ENGINE SHAFTS, AND A MEANS OF PROVING IF A SHAFT IS ACTUALLY BEDDING IN ITS BEARINGS.

(Continued from page 49.)

DISCUSSION.

MR. A. H. DYKES said that even if it was claimed that the idea was not altogether new, credit was due to Mr. Windeler for bringing the method prominently before engineers generally, and for giving the results of his experience with it.

He was bound to say that when he first heard of the method, he did not feel at all sure that there might be more spring in the shaft when the engine was working than when it was stationary, and that the opening of the crank-webs might be very little when the thrust of the piston was absent, but on corresponding with Mr. Windeler he was assured that this was not the case, and that the method had proved perfectly reliable.

Only a few days before he had been discussing the matter with a naval officer who had had charge of the Diesel engines on board H.M.S. "Benbow," and he was informed that in 1917 the method was in regular use on the "Benbow" and that a special micrometer had been designed, very similar in principle to the one shown by Mr. Windeler, for measuring the opening of the crank-webs.

In Mr. Dykes' opinion the method was a very useful one, but it must not be allowed to supersede periodical dismantling of the bearings for inspection, as, in addition to wear, one wanted to be sure that the bearings were being properly lubricated.

Mr. P. A. Holliday agreed with Mr. Dykes that the method of taking measurements between the crank-webs should only supplement the periodical inspection of bearings. The method described had been employed by Messrs. Bellis and Morcom for a number of years, chiefly in connection with checking the alignment of outer bearings of steam-driven air compressors, as well as in the case of overhung fly-wheels of steam sets; his firm advocated the method in the instructions which were issued for the care and management of those machines.

A point gauge and feelers were found to be quite satisfactory. The repeated gaugings should be taken from between the same points, and to accomplish this a slight indention in one of the crank-webs for the purpose of taking one end of the point gauge would have the desired effect.

The question of alignment of shafts was a very important one, and his firm had come into contact with several crankshaft failures in Continental Diesel engines, some of which might be attributed to want of accurate alignment. Anything that could be done to keep a check on crankshaft alignment should therefore be welcomed by engineers in charge of Diesel engines, as the strongest shafts were likely to fail if alignment were neglected.

Mr. F. Swarbrick said that it had been his unfortunate experience to run a Diesel engine having a fractured crankshaft. The engine had been run on two cylinders for about 500 hours. It had necessitated the carrying out of measurements between the crank-webs at very frequent intervals. Photographs were submitted at the meeting showing the nature of the temporary repairs that had been carried out on the shaft.

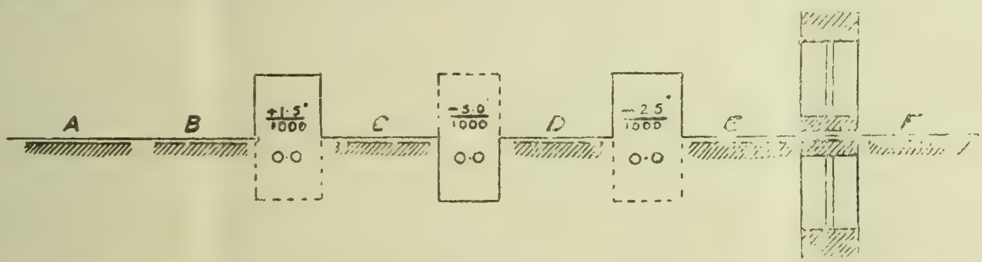
The method of measuring between the crank-webs could be carried out in the case of *horizontal* engines with equal success.

Mr. H. Squire, referring to the case in Mr. Windeler's paper that "a few thousandths difference in the dimensions between the crank-webs when the crank-pin was on top and bottom centres, indicated that the shaft was out of line," asked Mr. Windeler if he could give an actual figure as the maximum difference representing a limit of safety. He inquired if this should not be stated as a percentage of the stroke of the engine or of the web length between the journal and crank-pin.

He said that in the case of the Carels engines under his charge, the weight of the piston and connecting-rod was in the neighbourhood of 25 cwts., whereas the weight on the piston at the commencement of the firing stroke would be between 50 and 60 tons. Ought not some artificial load to be placed on the piston head on top dead centre to approach working conditions when measurements were being taken between the crank-webs? He suggested that this could be accomplished by introducing the blast when the engine was on top dead centre. The measurements between crank-webs could then be noted with blast on and blast off.

[Mr. Squire has since submitted the following measurements, taken on the lines suggested by Mr. Windeler, on the No. 3 Carels Diesel engine at Chelsea (300 B.H.P., 3-cylinder). In the case of each crank the measurement was first taken between the webs when on bottom centre. This measurement was taken as zero, the engine being then barred round to top dead centre and the measurement between webs again taken.]

Mr. H. S. Brackenbury stated that on three occasions the white metal of Nos. 2, 3, and 4 bearings of his engine had been broken away, which was due either to springing of the crank-shaft or to the crank-shaft not being properly aligned. In his opinion it was due to springing of the shaft. He added that the fault always occurred on the thrust side of the bearings, that is to say, the side nearest the vertical shafts, which seemed to point to the shaft springing.



Mechanical Clearance at Thrust Collar 16/1000 in. End Play (maximum) 18/1000 in.

(To be continued.)

FOUNDATIONS.

By W. H. Latham.

(Concluded from page 31.)

Reinforced concrete piles are made with a steel or cast-iron shoe and a skeleton or rods with a spiral of lighter section lashed to the longitudinal rods with soft iron wire. They are moulded in wooden boxes horizontally, and are driven at six or eight weeks after making. The Coignet and Stempel patterns of reinforcements are shown in Fig. 13. The mixture for piles is usually 1-1½-3 as against the 1-2-4 moisture used for ordinary work, and the aggregate should not exceed ¾ in.

A.C.I. helmet with a wooden dolly is used with sawdust packing for driving.

Piles are driven with a ram or hammer guided by a framing. The hammer is raised by a winch and dropped on the pile-head or helmet. A tripping hook is generally used and the releasing line attached to the pile, ensuring a constant drop. The hammers vary from half a ton up to three tons, and the drop may be from 2 ft. to 10 ft. The following rules are given by Professor Adams for the weight of the hammer :—

(1) Weight of hammer = weight of pile.

(2) Weight of hammer in cwts. = 3 (d—5) where d = dia. of pile in inches.

(3) Weight of hammer in cwts. $= \dfrac{L \times A}{450}$ where

L = length in feet and A = area in square inches.

There are several patterns of pile-driving machines in use of the direct acting type like a modified steam hammer.

The safe load on a pile is naturally somewhat debateable.

Saunders' formula is :—

$$\text{Sale load in tons} = \frac{3\,R\,H}{2d}.$$

McAlpine's formula is :—

$$\text{Safe load in tons} = 4\ (20\,R \times 228\sqrt{H} - 1).$$

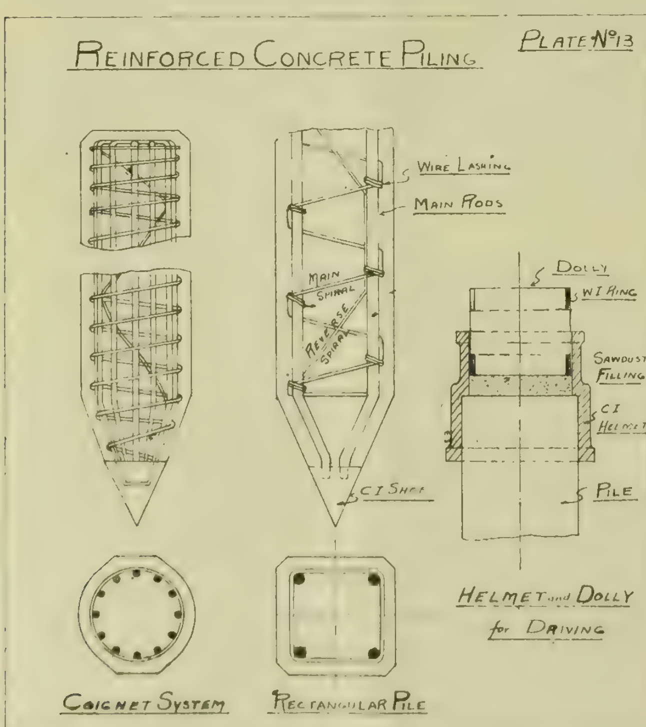
Where R = weight of hammer in tons.

H = drop of hammer in feet.

d = "set" or penetration of pile in inches for last blow.

The last quantity is an important factor in pile-driving, and, unfortunately, no definite rule seems to exist in the matter, although the pile is usually driven to a specified set, which, for timber piles, is generally 1 in. for eight blows of the hammer. For concrete piles it may be 1 in. for 10 blows of a two-ton hammer with a 4-ft. drop. Sometimes the pile is driven to "refusal," that is, until the pile will go no further. In such cases the pile may have to be lengthened in place.

With wooden piles a butt joint with long steel scarf



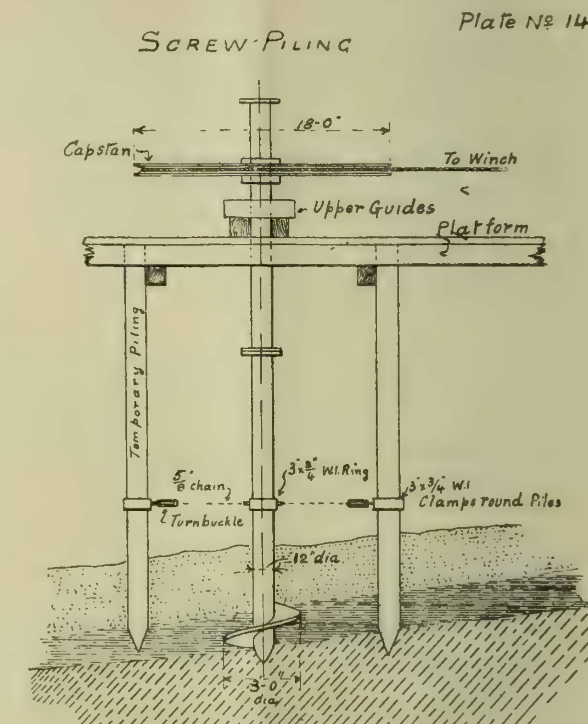
Foundations—Fig. 13.

plates is used. A concrete pile may have shuttering put up round it and an extra length moulded on.

In the case of wells, caissons, and piles it is generally assumed that the foot of the foundation reaches the solid ground, and no allowance is made for friction on the sides. In practice this is considerable, and the diagram on Fig. 15 shows the surface resistance in cwts. per square foot for different depths. The depth is taken to the lowest point and the resistance is supposed to be uniform all over the surface. It will be noticed that there is great variation in the actual results, but the curves may be taken as an approximate value for estimating purposes.

Screw-Piling.

On soft ground, and particularly on deep sand, another type of pile is used consisting of a cast-iron or steel tube



Foundations—Fig. 14.

with a short length of screw thread on the end. For small sizes and for work on sand the end is usually plugged and pointed. In some cases the tube is left open to allow of breaking the ground with a chisel where the pile is to enter a harder material than sand, or the use of a high pressure water jet in sand to facilitate sinking. The piles are screwed into the ground exactly as a wood screw is screwed into wood. A capstan head is built on the pile and a rope passed round it. The rope is carried to a winch and the pile turned by winding it on. For 12 in. diameter piles the capstan may be 18 to 20 ft. diameter and a 2-ton winch used for winding.

The bearing capacity of these piles is, of course, their projected area multiplied by the safe load on the ground.

Finally, as to the economy of foundations :

The plain concrete block is the easiest to construct, and for depths less than 5 ft. is usually cheapest.

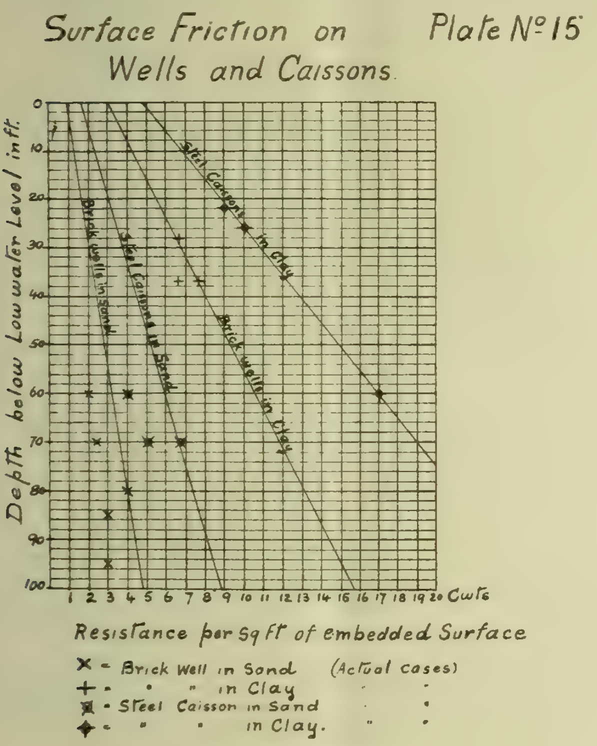
The reinforced concrete block is more difficult to make, and there is the cost of reinforcement, but the saving of excavation and concrete usually makes it possible to replace a plain foundation over 5 ft. deep by a reinforced concrete foundation with a saving in cost.

Piled and grillage foundations are usually required only for special work, such as bridge abutments and crane foundations, &c., or on very poor ground. Their

use is generally a matter of necessity. The grillages are very expensive.

Wells, cylinders and caissons are practically confined to underwater work.

The well is cheaper than the cylinder and the cylinder



FOUNDATIONS.—FIG. 15.

cheaper than the caisson, but in all these cases the choice depends really on the actual circumstances.

I am indebted to the Institution of Civil Engineers for leave to publish the Bell formula and the drawings and tables in connection with same.

(*Concluded.*)

A NEW THEORY OF PLATE SPRINGS.

By DAVID LANDAU AND PERCY H. PARR.

(*Continued from page 53.*)

HAVING completed our study of the reactions and deflections of springs with square-pointed leaves, we pass on to the study of the

No. 2 or Trapezoidal (Trap') Leaf Point.

This type of point is shown on a larger scale in Fig. 18, on which are also given the symbols which will be used in the analysis. The end of the leaf is of uniform thickness with the central portion, but it is cut off to a straight taper in the plane of the width.

We shall use I_0 to indicate the moment of inertia of the untapered portion of the plate, for this and for all other types of tapered points.

In order to determine the deflections of leaves with the No. 2 point we have:

First: From $X = 0$ *to* $X = l - a$.

For this portion of the leaf the cross-section is uniform, and equations (22) to (24a) for the No. 1 point apply directly.

Second: From $X = l - a$ *to* $X = l$.

For this portion of the leaf it is readily seen that the moment of inertia is:

$$I = I_0 \frac{l + b - x}{a + b}$$

and therefore:

$$\frac{E I_0}{W} \frac{d^2 y}{dx^2} = \frac{(a + b)(l - x)}{l + b - x} \quad \ldots\ldots\ldots\ldots (29)$$

Integrating this equation, and determining the value of the constant of integration from the fact that the value of dy/dx given by the integral for $x = l - a$ must be equal to that given by equation (23) for the same value of x, there results:

$$\frac{E I_0}{W} \frac{dy}{dx} = (a + b) x + (a + b) b \log \frac{l + b - x}{a + b}$$
$$+ (l - a - b)(l - a) - \frac{(l - a)^2}{2} \quad \ldots\ldots\ldots (30)$$

Integrating again, and determining the value of the constant of integration from the fact that the value of y given by the integral for $x = l - a$ must

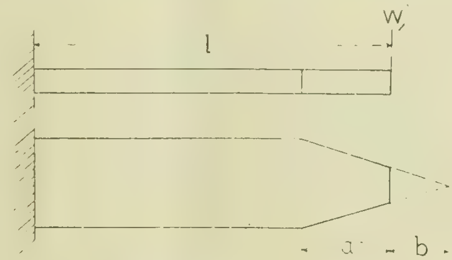


PLATE SPRINGS.—FIG. 18.

be equal to that given by equation (24) for the same value of x, there results:

$$\frac{EI_0}{W} y = (a + b) \frac{x^2}{2} + \left\{ \frac{(l - a)^2}{2} - b (l + b) \right\} x$$
$$- (a + b) b (l + b - x) \log \frac{l + b - x}{a + b} + (a + b) b (l - a)$$
$$+ \frac{b (l - a)^2}{2} - \frac{(l - a)^3}{6} \quad \ldots\ldots\ldots\ldots (31)$$

When using these equations it must be remembered that the logarithms are natural or hypobolic ones, to the base e, and not the common logarithms to the base 10.

At the end of the leaf, where $x = l$, the above two equations reduce to:

$$\frac{EI_0}{W} \frac{dy}{dx} = \frac{l^2 + a^2}{2} + ab + (a + b) b \log \frac{b}{a + b} \quad \ldots . (30a)$$

$$\frac{EI_0}{W} y = \frac{al^2}{2} - \frac{ab (a + 2b)}{2} + \frac{(l - a)^2 (2l + a)}{6}$$
$$- (a + b) b^2 \log \frac{b}{a + b} \quad \ldots\ldots\ldots\ldots\ldots (31a)$$

These equations from point No. 2 are very much more complex than are the corresponding ones for point No. 1, but there is no real difficulty in applying them to any particular case—it being merely a matter of arithmetical work. For the sake of uniformity and in order that comparisons may be

made, we now apply these equations to the spring shown in Fig. 19, which is the same as that of Fig. 17 except that the leaves have been given a No. 2 taper.

Plate No. 1.

We have $l=4$, $a=1.5$, and $b=1$; and on inserting these values into equation (31a) there results:

$$\frac{EI_1}{W_1}y_1 = \frac{1\cdot5\times4^2}{2} - \frac{1\cdot5\times1(1\cdot5+2\times1)}{2} + \frac{(4-1\cdot5)^2(8+1\cdot5)}{6}$$

$$-(1\cdot5+1)\log\frac{1}{1\cdot5+1}$$

$$=21\cdot5636$$

and since $EI_1 = 30772$ (see example of point No. 1 for I, etc.) we have $y_1 = .0007008\ W_1$, or

$$A_1 = .0007008.$$
$$A_2 = 0 \text{ as always.}$$

Plate No. 2.

The reaction W_1 is applied to the non-tapered portion of plate No. 2, so that A_3 and A_4 will be the same as in the example of the No. 1 point, that is:

$$A_3 = .0004366.$$
$$A_4 = .0007641.$$

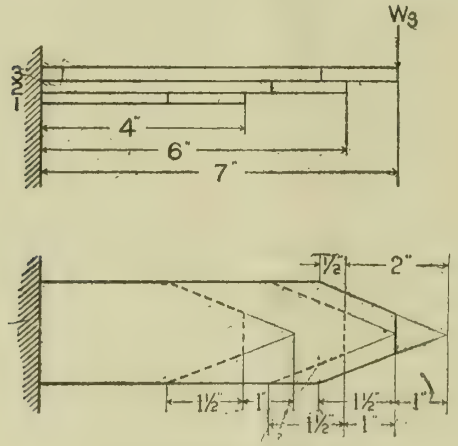


Plate Springs — Fig. 19.

For A_5 we have $l = 6$, $a = 1.5$ and $b = 1$ as before, and on inserting these values in equation (31a) it will be found that

$$y_5 = .001478\ W_2,$$

or

$$A_5 = .001478.$$
$$A_6 = A_4 = .0007641.$$

Plate No. 3

For A_7 and A_8 the reaction W_2 acts at $l_2 = 6$, and from Fig. 19 it will be seen that in this case $a = .5$ and $b = 2$; inserting these values in equation (31a) it will be found that:

$$A_7 = .0009875.$$

It will be noticed that the value of A_7 for this case is the same as that found in the previous one, and so it follows that A_8 will be the same as before. If not, then we should have to find the value of dy/dx for $x = l_2 = 6$, multiply this by $l_3 - l_2 = 7 - 6 = 1$ in this case, and add the result to A_7, in order to obtain A_8.

$$A_8 = .001234.$$

For A_9 we have W_3 acting at the distance $l = 7$, $a = 1.5$, and $b = 1$, so that, on inserting into equation (31a) and reducing,

$$A_9 = .001571.$$
$$A_{10} = A_8 = .001234.$$

Making the other calculations, in the same manner as in the previous example, for the No. 1 point, it will be found that:

$$B_1 = .0007008.$$
$$C_1 = .6718.$$
$$B_2 = .0009647.$$
$$C_2 = .6321.$$
$$B_3 = .0007910.$$

$W_2 = 1.489\ W_1 = 436$ lbs. for $W_1 = 293$ lbs. as before:

$$W_3 = 2{,}356\ W_1 = 690 \text{ lbs.}$$

also the maximum stress in plate No. 3 will be 106,240 lbs. per sq. in., and the stiffness will be 1,264 lbs. per inch deflection.

On comparing these results with those for the No. 1 point, it will be found that the differences are negligible, so that we may state definitely that the No. 2 point, of proportions as generally found in practice, has no advantage whatever, and that it is a waste of time and money to trim the points to this shape. The only advantage of the No. 2 point over the No. 1 is that of appearance—it pleases some people—but is really of no benefit as regards endurance of the spring.

With an actual spring, of course, the master leaf must have a square point instead of the No. 2 point shown in Fig. 19; this simply means that the equations (22) to (24a) for the No. 1 point must be used when calculating the values of the A's for this leaf.

(To be continued.)

DETERMINING THE SIZES OF STEAM ENGINE CYLINDERS.

By Edward Ingham, A.M.I.Mech.E.

No Complexity in the Problem.

The question of determining the sizes of the cylinders of a steam engine to develop a given horse power is often regarded as one of considerable difficulty, and many draughtsmen feel themselves quite incapable of dealing with such a problem, particularly in the case of a triple expansion engine. Why this should be so is not easy to explain, because there is really nothing of a complex nature about the problem, and no one who understands the elementary principles of heat engines should experience any difficulty.

In this article, we propose to explain the general method of calculating the sizes of the cylinders required for any particular power, and to consider an actual example, viz., that of a compound or two-cylinder engine, after which the procedure for a triple-expansion, or three-cylinder, engine will be explained.

At the outset it is necessary to mention, for the benefit of those whose ideas of the subject are somewhat hazy, that in all cases the low-pressure cylinder must be sufficiently large to develop the total power; the other cylinders merely serve to alter the distribution of the steam. Hence, we must calculate the size of the low-pressure cylinder on the assumption that the whole of the power is to be developed in that cylinder.

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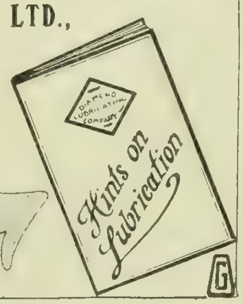

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Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 0 22	8 1 16	12 2 10	0 16 3 4	1 0 3 26	1 5 0 20	1 9 1 14	1 13 2 8	1 17 3 2	0
1	0 1 19	4 2 13	8 3 7	13 0 1	0 17 0 23	1 1 1 17	1 5 2 11	1 9 3 5	1 13 3 27	1 18 0 21	1
2	0 3 10	5 0 4	9 0 26	13 1 20	0 17 2 14	1 1 3 8	1 6 0 2	1 10 0 24	1 14 1 18	1 18 2 12	2
3	1 1 1	5 1 23	9 2 17	13 3 11	0 18 0 6	1 2 0 27	1 6 1 21	1 10 2 15	1 14 3 9	1 19 0 3	3
4	1 2 20	5 3 14	10 0 8	14 1 2	0 18 1 24	1 2 2 18	1 6 3 12	1 11 0 6	1 15 1 0	1 19 1 22	4
5	2 0 11	6 1 5	10 1 27	14 2 21	0 18 3 15	1 3 0 9	1 7 1 3	1 11 1 25	1 15 2 19	1 19 3 13	5
6	2 2 2	6 2 24	10 3 18	15 0 12	0 19 1 6	1 3 2 0	1 7 2 22	1 11 3 16	1 16 0 10	2 0 1 4	6
7	2 3 21	7 0 15	11 1 9	15 2 3	0 19 2 25	1 3 3 19	1 8 0 13	1 12 1 7	1 16 2 1	2 0 2 23	7
8	3 1 12	7 2 6	11 3 0	15 3 22	1 0 0 16	1 4 1 10	1 8 2 4	1 12 2 26	1 16 3 20	2 1 0 14	8
9	3 3 3	7 3 25	12 0 19	16 1 13	1 0 2 7	1 4 3 1	1 8 3 23	1 13 0 17	1 17 1 11	2 1 2 5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 3·91	0 7·83	0 11·75	0 15·66	0 19·58	0 23·50	0 27·41	1 3·33	1 7·25	1 11·17	1 15·08	1 19	

Weights of Lengths of Rolled Steel Sections.

Beam 10 in. × 6 in. × 47 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 1 3 24	4 3 3 20	6 5 3 16	8 7 3 12	10 9 3 8	12 11 3 4	14 13 3 0	16 15 2 24	18 17 2 20	0
10	0 4 0 22	2 6 0 18	4 8 0 14	6 10 0 10	8 12 0 6	10 14 0 2	12 15 3 26	14 17 3 22	16 19 3 18	19 1 3 14	10
20	0 8 1 16	2 10 1 12	4 12 1 8	6 14 1 4	8 16 1 0	10 18 0 24	13 0 0 20	15 2 0 16	17 4 0 12	19 6 0 8	20
30	0 12 2 10	2 14 2 6	4 16 2 2	6 18 1 26	9 0 1 22	11 2 1 18	13 4 1 14	15 6 1 10	17 8 1 5	19 10 1 2	30
40	0 16 3 4	2 18 3 0	5 0 2 24	7 2 2 20	9 4 2 16	11 6 2 12	13 8 2 8	15 10 2 4	17 12 2 0	19 14 1 24	40
50	1 0 3 26	3 2 3 22	5 4 3 18	7 6 3 14	9 8 3 10	11 10 3 6	13 12 3 2	15 14 2 26	17 16 2 22	19 18 2 18	50
60	1 5 0 20	3 7 0 16	5 9 0 12	7 11 0 8	9 13 0 4	11 15 0 0	13 16 3 24	15 18 3 20	18 0 3 16	20 2 3 12	60
70	1 9 1 14	3 11 1 10	5 13 1 6	7 15 1 2	9 17 0 26	11 19 0 22	14 1 0 18	16 3 0 14	18 5 0 10	20 7 0 6	70
80	1 13 2 8	3 15 2 4	5 17 2 0	7 19 1 24	10 1 1 20	12 3 1 16	14 5 1 12	16 7 1 8	18 9 1 4	20 11 1 0	80
90	1 17 3 2	3 19 2 26	6 1 2 22	8 3 2 18	10 5 2 14	12 7 2 10	14 9 2 6	16 11 2 2	18 13 1 26	20 15 1 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	20 19 2 16	41 19 1 4	62 18 3 20	83 18 2 8	104 18 0 24	125 17 3 12	146 17 2 0	167 17 0 16	188 16 3 4	209 16 1 20	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 12 in. × 6 in. × 48 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 1 4	8 2 8	12 3 12	0 17 0 16	1 1 1 20	1 5 2 24	1 10 0 0	1 14 1 4	1 18 2 8	0
1	0 1 20	4 2 24	9 0 0	13 1 4	0 17 2 8	1 1 3 12	1 6 0 16	1 10 1 20	1 14 2 24	1 19 0 0	1
2	0 3 12	5 0 16	9 1 20	13 2 24	0 18 0 0	1 2 1 4	1 6 2 8	1 10 3 12	1 15 0 16	1 19 1 20	2
3	1 1 4	5 2 8	9 3 12	14 0 16	0 18 1 20	1 2 2 24	1 7 0 0	1 11 1 4	1 15 2 8	1 19 3 12	3
4	1 2 24	6 0 0	10 1 4	14 2 8	0 18 3 12	1 3 0 16	1 7 1 20	1 11 2 24	1 16 0 0	2 0 1 4	4
5	2 0 16	6 1 20	10 2 24	15 0 0	0 19 1 4	1 3 2 8	1 7 3 12	1 12 0 16	1 16 1 20	2 0 2 24	5
6	2 2 8	6 3 12	11 0 16	15 1 20	0 19 2 24	1 4 0 0	1 8 1 4	1 12 2 8	1 16 3 12	2 1 0 16	6
7	3 0 0	7 1 4	11 2 8	15 3 12	1 0 0 16	1 4 1 20	1 8 2 24	1 13 0 0	1 17 1 4	2 1 2 8	7
8	3 1 20	7 2 24	12 0 0	16 1 4	1 0 2 8	1 4 3 12	1 9 0 16	1 13 1 20	1 17 2 24	2 2 0 0	8
9	3 3 12	8 0 16	12 1 20	16 2 24	1 1 0 0	1 5 1 4	1 9 2 8	1 13 3 12	1 18 0 16	2 2 1 20	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	4	8	12	16	20	24	1 0	1 4	1 8	1 12	1 16	1 20	

Weights of Lengths of Rolled Steel Sections.

Beam 12 in. × 6 in. × 48 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 2 3 12	4 5 2 24	6 8 2 8	8 11 1 20	10 14 1 4	12 17 0 16	15 0 0 0	17 2 3 12	19 5 2 24	0
10	0 4 1 4	2 7 0 16	4 10 0 0	6 12 3 12	8 15 2 24	10 18 2 8	13 1 1 20	15 4 1 4	17 7 0 16	19 10 0 0	10
20	0 8 2 8	2 11 1 20	4 14 1 4	6 17 0 16	9 0 0 0	11 2 3 12	13 5 2 24	15 8 2 8	17 11 1 20	19 14 1 4	20
30	0 12 3 12	2 15 2 24	4 18 2 8	7 1 1 20	9 4 1 4	11 7 0 16	13 10 0 0	15 12 3 12	17 15 2 24	19 18 2 8	30
40	0 17 0 16	3 0 0 0	5 2 3 12	7 5 2 24	9 8 2 8	11 11 1 20	13 14 1 4	15 17 0 16	18 0 0 0	20 2 3 12	40
50	1 1 1 20	3 4 1 4	5 7 0 16	7 10 0 0	9 12 3 12	11 15 2 24	13 18 2 8	16 1 1 20	18 4 1 4	20 7 0 16	50
60	1 5 2 24	3 8 2 8	5 11 1 20	7 14 1 4	9 17 0 16	12 0 0 0	14 2 3 12	16 5 2 24	18 8 2 8	20 11 1 20	60
70	1 10 0 0	3 12 3 12	5 15 2 24	7 18 2 8	10 1 1 20	12 4 1 4	14 7 0 16	16 10 0 0	18 12 3 12	20 15 2 24	70
80	1 14 1 4	3 17 0 16	6 0 0 0	8 2 3 12	10 5 2 24	12 8 2 8	14 11 1 20	16 14 1 4	18 17 0 16	21 0 0 0	80
90	1 18 2 8	4 1 1 20	6 4 1 4	8 7 0 16	10 10 0 0	12 12 3 12	14 15 2 24	16 18 2 8	19 1 1 20	21 4 1 4	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	21 8 2 8	42 17 0 16	64 5 2 24	85 14 1 4	107 2 3 12	128 11 1 20	150 0 0 0	171 8 2 8	192 17 0 16	214 5 2 24	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

It will be understood that the object of using two or more cylinders is chiefly to take full advantage of the expansive properties of the steam. The higher the ratio of expansion which can be adopted, the greater is the economy effected. Where the initial steam pressure is very high, it is usual to provide three cylinders, but for moderate pressures a two-cylinder engine is generally employed.

Fixing the Sizes.

The usual procedure of a steam engine maker in fixing the sizes of the cylinders of an engine is as follows:—A suitable ratio of expansion is first fixed upon, this, of course, being governed by the boiler pressure and the terminal pressure in the low-pressure cylinder. The mean effective pressure is next calculated, assuming the whole of the power is to be generated in the low-pressure cylinder. It is assumed that the steam expands in accordance with Boyle's Law—*i.e.*, the pressure varies inversely as the volume. This is not strictly correct; but since we are allowed a good deal of latitude, there is no harm in making the assumption, which is a very convenient one, and simplifies the calculations. The mean effective pressure, assuming there are no losses, may be calculated from the following formula:—

$$p_m = \frac{p_1 (1 + \log r)}{r} - p_b,$$

where p_m = the mean effective pressure in lbs. per sq. in.
p_1 = the initial absolute pressure in lbs. per sq. in.
r = the ratio of expansion.
p_b = the back pressure in lbs. per sq. in. (absolute).

The pressure calculated in the foregoing manner is the theoretical mean effective pressure. In practice, this pressure would not be realised, because the actual indicator diagram differs from the theoretical diagram. For example, in the latter diagram, cut-off and release are instantaneous, but since no type of valve gear can give an instantaneous cut-off and release, there is a rounding off of the diagram and, consequently, a loss of useful work area. Other differences occur, so that the work area, and consequently the mean pressure of the actual diagram, are less than in the case of the theoretical diagram.

It is therefore necessary to multiply the theoretical mean pressure by a suitable diagram factor—that is to say, a fraction which represents the ratio of the actual mean pressure to the theoretical mean pressure. The value of the diagram factor will, of course, depend upon a number of circumstances, but for an ordinary horizontal Corliss engine it may be assumed to be .8.

By multiplying the theoretical mean pressure by the diagram factor, we obtain the probable mean pressure in the low-pressure cylinder, and the area of the cylinder can now be calculated by the formula for the horse power of an engine, thus:

$$\text{Horse power} = \frac{2\,P\,A\,L\,N}{33{,}000}$$

where P = the mean effective pressure in pounds per square inch.
A = the area of piston in square inches.
L = the length of stroke in feet.
N = the number of revolutions per minute.

Cylinder Volume Ratio.

After the size of the low-pressure cylinder has been fixed, a suitable cylinder volume ratio must be decided upon, in order that the area and the diameter of the other cylinder may be calculated.

For compound engines the ratio of the volume of the high-pressure cylinder to that of the low-pressure cylinder is usually about 1:4. In the case of triple-expansion engines, the ratio of the three cylinders is commonly about 1:2.5:7.

It will be seen that there is nothing difficult in the problem with which we are concerned, but the following actual case will serve to render the matter quite clear in all its details.

Example.—Determine the sizes of the cylinders of a compound engine to develop 1,000 I.H.P., the boiler pressure being 115 lbs. per square inch absolute (100 lbs. gauge), and the terminal pressure 10 lbs. absolute, back pressure 3 lbs. absolute, and piston speed 700 ft. per minute.

Solution.—We must first determine the ratio of expansion. The initial absolute pressure is 115 lbs. per square inch, but it must be remembered that a certain drop of pressure will occur between the boilers and the engine, the drop depending upon the length of steam piping and the efficiency of the pipe covering, etc. In this case, we will assume the engines and boilers are close together, and the pipes efficiently covered, so that the drop in pressure is only 5 lbs. per square inch. Since, then, the initial pressure in the high-pressure cylinder will be 110 lbs. per square inch, whilst the terminal pressure is 10 lbs. per square inch, the number of expansions will be

$$\frac{110}{10} = 11.$$

Finding the Mean Effective Pressure.

We can now find the mean effective pressure (assuming all the work to be done in the low-pressure cylinder) from the formula already given, viz.—

$$p_m = \frac{p_1 (1 + \log_e r)}{r} - p_b,$$

the letters representing the quantities already specified. Substituting the given values, we have—

$$p_m = \frac{110 (1 + \log_e 11)}{11} - 3$$

$$= \frac{110 (1 + 2.398)}{11} - 3 = 31 \text{ lbs. per sq. in.}$$

Hence, assuming there are no losses, the mean effective pressure in the cylinder would be 31 lbs. per square in. This figure must, however, be multiplied by a suitable diagram factor, which, for this case, we may take to be .8.

Therefore, the probable mean effective pressure equals 24.8 lbs. per square inch.

The next thing to do is to fix the speed of the engine, in revolutions per minute, and the length of the piston stroke. If we assume the former to be 100 revolutions per minute, then, since the piston speed is given as 700 ft. per minute, the stroke will be

$$\frac{700}{2 \times 100} = 3.5 \text{ ft.}$$

We have now all the particulars for finding the area of the cylinder, using the formula:

$$HP = \frac{2\ P\ A\ L\ N}{33{,}000};$$

the letters representing the quantities already specified. Rearranging the formula—

$$A = \frac{HP \times 33.000}{2\ P\ L\ N}.$$

Substituting the known values—

$$A = \frac{1000 \times 33{,}000}{2 \times 24.8 \times 3.5 \times 100} = 1900 \text{ sq. ins.}$$

From tables, we find the diameter of a circle having an area of 1900 square inches is $49\frac{1}{4}$ ins. approximately. The required diameter of the low-pressure cylinder is therefore $49\frac{1}{4}$ ins.

In order to find the diameter of the high-pressure cylinder, we shall suppose the cylinder ratio to be 1 : 4. Hence, area of high-pressure cylinder equals

$$\frac{1900}{4} = 475 \text{ sq. ins.}$$

From tables, the diameter corresponding to this area is found to be $24\frac{5}{8}$ in. approximately.

Therefore, the diameter of the high-pressure cylinder equals $24\frac{5}{8}$ ins.

In the case of a triple expansion engine, the method of working is very similar to the foregoing; in fact, the sizes of the low-pressure and the high-pressure cylinders may be determined in exactly the same way. Of course, the ratio of the volume of the high-pressure to that of the low-pressure cylinder will be less than in the case of the compound engine. The ratio is, as already stated, generally about 1 : 7, whilst the ratio of the high-pressure cylinder to the intermediate is about 1 : 2.5. If, then, we have found the diameter of the high-pressure cylinder, that of the intermediate cylinder is obtained by multiplying the former diameter by $\sqrt{2{\cdot}5}$, since the area of a cylinder varies as the square of its diameter. For the sake of example, suppose that the diameter of the high-pressure cylinder is 30 ins. Then, adopting the ratio of 1 : 2.5, the diameter of the intermediate pressure cylinder will be $30 \times \sqrt{2.5} =$ 47.5 ins. approximately.

If we wish to find the point of cut-off in the high-pressure cylinder, this is done by dividing the ratio of the low-pressure to the high-pressure cylinder by the total number of expansions. Thus—

$$\text{Point of cut-off} = \frac{\text{Ratio of low-pressure cylinder to high-pressure cylinder}}{\text{Total number of expansions.}}$$

For the example first given, the point of cut-off in the high-pressure cylinder is

$$\frac{4}{11} = .363,$$

or approximately one-third.

A question which may arise in connection with the foregoing is the following:—If the low-pressure cylinder of an engine be made sufficiently large to develop all the power required, then will not the addition of a high-pressure cylinder mean that more power will be actually developed than was intended? The answer to this is in the negative, because, by adding the high-pressure cylinder, some of the work which would have had to be done in the low-pressure cylinder, were this the only cylinder provided, is now done in the smaller cylinder. Hence, the actual mean effective pressure in the low-pressure cylinder will be less than the pressure as calculated in the first instance. If all the work were done in a single cylinder, the full initial pressure would come upon the piston at the beginning of the stroke, the cut-off would be very early, and the pressure of steam would fall throughout the full range in one cylinder. This would mean excessive variation in the turning effort, and great loss by condensation of steam due to the large variation of temperature which would occur in the cylinder during each stroke. By the addition of one or more cylinders, these difficulties are to a large extent obviated.

MOTOR TRANSPORT ON THE ANGLO-PERSIAN OILFIELDS.

During the progress of military operations of the British Forces in Mesopotamia against the Turks, it became apparent that, should the enemy succeed in penetrating to the Anglo-Persian oilfields, it would strike a vital blow at British interests and prestige generally. It was, therefore, essential to employ strong forces to guard the valuable oilfields,

Motor Transport on the Anglo-Persian Oilfields.

as well as patrol the 90 odd miles of pipe line through which the oil flows to the Anglo-Persian Co.'s headquarters.

The question of transporting munitions and supplies in this district was a difficult problem. Animal transport was employed in the earlier stages, but the district was absolutely virgin to mechanically-propelled vehicles of any kind. Later on it was decided to experiment with motor vehicles, and Napier business vehicles were decided upon. Ten of these were employed on the work from September, 1916; the distance of 130 miles was accomplished in two days, a remarkable performance having regard to the heavy running through the desert sand.

A correspondent who was with the Forces writes as follows:—"These Napier business vehicles proved themselves extremely lively and efficient, responding most gamely to all calls made upon them in the course of this arduous journey." From that date Napiers were used continuously for the journey until Lord Allenby finally brought the Turk to his knees.

CHIMNEY STACKS.

By James Claughton.

(*Continued from page 50.*)

Report on Boiler Test made at the Lancashire and Yorkshire Railway Co., Ltd., Electric Power Station, Formby, near Liverpool.

The test was carried out by Messrs. H. G. O'Brien, J. Millington, J. Billington, S. E. Povey, A. E. Carr, and Staff, Observers for the Railway Company, and Messrs. E. Bennis, A. W. Bennis, and A. M. Hicks, for Messrs. Ed. Bennis & Co., Ltd.

System of Firing. "Bennis" Sprinkler Stokers and Compressed Air Furnaces.

Date of Test	November 27.
Duration of Test	8 hours.
(A) Particulars of the Boilers Used :	
Number of boilers	8.
Type of boiler	Lancashire.
Size of boiler	8′ 6″ × 32′ 0″.
Heating surface of each boiler	1,200 sq. ft.
Grate surface of each boiler	45 sq. ft.
Ratio of heating surface to grate surface	26·67 : 1.
Nature of draught (natural, forced, or induced)	Induced.
Type of mechanical firing apparatus, if any	"Bennis."
Heating surface of economiser, if any	7,200 sq. ft.
Heating surface of superheater per boiler	158 sq. ft.
(B) Conditions of Combustion (Average) :	
Draught in inches of water gauge—downtakes	·31 inches.
Draught in inches of water guage—in main flue	·77 inches.
Draught in inches of water gauge—at fan	1·1 inches.
Temperature of flue gases—leaving boiler	830 deg. Fah.
Temperature of flue gases—leaving economiser	358 deg. Fah.
Percentage of CO_2 in flue gases—main flue	12·7 per cent.
Percentage of CO_2 in flue gases leaving economiser	12·4 per cent.
(C) Conditions of Evaporation (Averages) :—	
Temperature of feed water—entering economiser	52·8 deg. Fah.
Temperature of feed water—entering boiler	196·4 deg. Fah.
Steam pressure by gauge	155·5 lbs. per sq. in.
Corresponding saturation temperature	368·51 deg. Fah.
Temperature of steam leaving superheater	503·7 deg. Fah.
Number of degrees of superheat	135·19 deg. Fah.
Heat supplied to each lb. of water in economiser	144·19 B.Th.U.
Heat supplied to each lb. of water—in boiler	1,029·25 B.Th.U.
Heat supplied to each lb. of water in superheater	74·35 B.Th.U.
Heat supplied to each lb. of water total	1247·79 B.Th.U.
Factor of equivalent evaporation as from and at 212 deg. Fah. (boiler and economiser and superheater)	1·2920.
(D) Nature of Coal Used :	
Name of coal	White Moss.
Class of coal	Ordinary slack.
Calorific value of coal per lb. dry	12,762 B.Th.U.
Approximate analysis of coal : Volatile matter	27·52 per cent.
Approximate analysis of coal : Fixed carbon	54·97 per cent.
Approximate analysis of coal : Ash	8·21 per cent.
Approximate analysis of coal : Moisture	9·30 per cent.
(E) Quantity of Dry Coal Used :—	
Total weight of coal burnt	82,740 lbs.
Coal burnt per boiler per hour	1,293 lbs.
Coal burnt per sq. ft. grate surface per hour	28·73 lbs.
Total weight of ash and clinker	7,392 lbs.
Percentage of ash and clinker to weight of coal	8·93 per cent.
(F) Quantity of Water Evaporated (Actual) :—	
Total quantity of water evaporated	686,326 lbs.
Water evaporated per boiler per hour	10,724 lbs.
Water evaporated per sq. ft. boiler heating surface per hour	8·94 lbs.
Water evaporated per lb. of coal	8·29 lbs.
Total heat supplied to water per lb. of coal	10,350 B.Th.U.
(G) Equivalent Quantity of Water Evaporated, as from and at 212 deg. Fah. :—	
Total equivalent evaporation	886,717 lbs.
Equivalent evaporation per boiler per hour	13,855 lbs.
Equivalent evaporation per sq. ft. boiler heating surface per hour	11·55 lbs.
Equivalent evaporation per lb. of coal	10·72 lbs.
(H) Efficiency and Economic Result :—	
Total thermal efficiency obtained	81·10 per cent.
Summary of Results :—	
Coal burnt per sq. ft. grate surface per hour	28·73 lbs.
Water evaporated, as from and at 212 deg. Fah. per sq. ft. boiler heating surface per hour	11·55 lbs.
Water evaporated, as from and at 212 deg. Fah. per lb. of coal	10·72 lbs.
Total thermal efficiency obtained	81.10 per cent.

The following is a Report of a Test on Babcock and Wilcox Water-tube Boiler, fitted with Chain Grate Mechanical Stoker and Superheater, the Mechanical Stoker being electrically driven.

The test was carried out at the Metropolitan Borough of Islington Electricity Station by Mr. G. F. Mertzger, M.I.C.E., of Manchester.

Duration of Test	22½ hours.
Fuel :	
Bituminous coal, obtained from Cotes Park Colliery, and known as Riddings Unwashed Screened Nuts.	
Calorific value of coal as fired (nett)	12,165 B.Th.U.
Thickness of fire	6·25 inches (average).
Total coal fired (dry)	46,135¾ lbs.
Total coal fired (wet)	51,021 lbs.
Coal consumed per hour	2,284½ lbs. (average).
Coal consumed per sq. ft. of grate area per hour	28·56 lbs.
Ash and clinker (residue)	2,800 lbs.
Percentage of residue to coal burnt	5·49 per cent.
Percentage of moisture	9·575 per cent.
Total combustible	43,334·69 lbs.
Boiler :	
Heating surface of boiler	5,540 sq. ft.
Type of stoker	Babcock and Wilcox "chain grate."
Area of grate	80 sq. ft.
Ratio of heating surface to grate area	69·25 to 1.
Current consumption of stoker motor	·911 of a unit per hour.
Steam :	
Quality	Superheated.
Average pressure per sq. in.	149·5 lbs.
Saturated steam temperature	365·45 deg. Fah.
Superheated steam temperature	445·83 deg. Fah.
Degree of superheat	80·38 deg. Fah.

WATER :—	
Total evaporated	455,296·68 lbs.
Evaporated per hour (actual)	20,386·42 lbs.
Evaporated per hour from and at 212 deg. Fah.	22,926·57 lbs.
Evaporated per sq. ft. of heating surface from and at 212 deg. Fah.	4·138 lbs.
Evaporated per lb. of coal as fired, actual conditions	8·92 lbs.
Evaporated per lb. of dry coal actual conditions	9·87 lbs.
Evaporated per lb. of coal as fired from and at 212 deg. Fah.	10·03 lbs.
Evaporated per lb. of dry coal, from and at 212 deg. Fah.	11·10 lbs.
Evaporated per lb. of combustible, actual conditions	10·51 lbs.
Evaporated per lb. of combustible, from and at 212 deg. Fah.	11·82 lbs.
Calculated factor of evaporation, allowing for superheat	1·1246.
DRAUGHT :—	
Natural, created by means of a chimney stack. The measurements were made by "draught" gauges, fixed in the middle and damper chambers of the boiler, also in the base of the chimney stack.	
At the chimney base	1 in.
At the end chamber	·53 in.
At the middle chamber	·46 in.
TEMPERATURES :—	
Boiler room	71·05 deg. Fah.
Average of feed water	183·35 deg. Fah.
Boiler wall, outside furnace } For radiation.	155·7 deg. Fah.
Boiler wall, middle chamber } For radiation.	152·56 deg. Fah.
Fire bars after complete revolution	130 deg. Fah.
FLUE GAS ANALYSIS :—	
CO_2	12·41 per cent.
EFFICIENCY :—	
Boiler and superheater	79·65 per cent.

REPORT OF A TEST CARRIED OUT AT MESSRS. ASHWORTH, HADWEN & CO., DROYLSDEN COTTON MILLS, MANCHESTER, by the representatives of Messrs. Drake and Gorham and Messrs. Babcock and Wilcox, on two Babcock and Wilcox water-tube boilers, fitted with chain grate mechanical stokers and superheaters, in conjunction with an economiser.

DURATION OF TEST	8 hours.
FUEL :—	Florence washed beans.
Calorific value (dry)	13,182 B.Th.U.
Fixed carbon and sulphur	58·4 per cent.
Volatile matter	33·7 per cent.
Ash, by analysis	7·9 per cent.
Ash, actual	6·3 per cent.
Moisture	7·25 per cent.
Thickness of fire	3·5 in.
Total coal fired (wet)	17,920 lbs.
Total coal fired (dry)	16,621 lbs.
Coal consumed per hour (wet)	2,240 lbs.
Coal consumed per sq. ft. of grate area per hour	20·27 lbs.
Total ash	1,234 lbs.
BOILER :—	
Heating surface of boilers (two)	4,874 sq. ft.
Type of stoker	Babcock and Wilcox "chain grate."
Grate area of stokers (two)	110·5 sq. ft.
Ratio of heating surface to grate area	44·1 to 1.
Heating surface of superheaters (two)	816 sq. ft.
Type of economiser	"Green's."
STEAM :—	
Quality	Superheated.
Average pressure per sq. in.	184 lbs.
Saturated steam temperature	381 deg. Fah.
Superheated steam temperature	526 deg. Fah.
Degree of superheat	145 deg. Fah.

WATER :—	
Total evaporated	151,062 lbs.
Evaporated per hour (actual)	18,882 lbs.
Evaporated per hour, from and at 212 deg. Fah.	24,546 lbs.
Evaporated per sq. ft. of heating surface, from and at 212 deg. Fah.	5 lbs.
Evaporated per lb. of coal (wet) (actual)	8·43 lbs.
Evaporated per lb. of coal (dry) (actual)	9·08 lbs.
Evaporated per lb. of coal (wet) from and at 212 deg. Fah.	10·95 lbs.
Evaporated per lb. of coal (dry), from at and 212 deg. Fah.	11·8 lbs.
Calculated factor of evaporation, including superheat	1·3.
DRAUGHT :—	
Measured in flue	·33 in.
TEMPERATURES :—	
Boiler room	60 deg. Fah.
Average feed water, entering economiser	58 deg. Fah.
Average of water entering boiler	144 deg. Fah.
Flue temperature, boiler damper	546 deg. Fah.
FLUE GAS ANALYSIS :—	
CO_2	10·1 per cent.
EFFICIENCY :—	
Boiler and superheater	80·5 per cent.
Boiler, superheater, and economiser	86·43 per cent.

During the last decade a striking feature is the new methods that have been employed for raising steam. Taken altogether they can for the most part be classed as "Gas-fired" boilers. The exact method of carrying this system out varies considerably with each individual furnace. A few of these systems may be briefly described as follows :—

Firstly: The gas-fired boiler, using either town's gas or specially made producer gas. In the latter category, we should also place those boilers that are fired by the surplus gas from coke oven installations, blast furnace plants, and similar undertakings.

Secondly: The waste heat boiler.—In this case the waste gases of combustion are diverted so as to flow along the boiler flues of ordinary steam boilers. Generally the waste heat, or waste gases, are derived from the following sources: Coke oven plants, metallurgical furnaces, and other steel or chemical works plant.

Although the writer has had considerable experience in the above specialities, and possesses valuable information concerning them, he finds it a very difficult problem to generalise this matter for public use. The reason for this difficulty arises on account of the fact that no two plants are alike; then again, there is the question of the class of coal used in carbonisation. The variety is so great, and the methods of carbonisation so varied, that the question is one that must be determined on the site.

In the particular cases concerning purely "waste heat fired" boilers, it will be evident that this is, generally speaking, purely experimental; *i.e.*, the number of boilers that can be conveniently used must depend entirely on site conditions. In this latter, engineers are always up against the constantly varying quantity of waste gases delivered to the boilers, on account of the continual stopping and starting of the various units forming the plant. In all plants where the foregoing is of frequent occurrence, special precautions have to be taken, and in many cases auxiliary appliances are fitted to enable the steam output to be maintained. This particularly applies when the steam is used for the generation of electricity.

We have many examples of these types of steam generating plants at several collieries, steel works, gas works, and chemical works in various parts of this country and the Continent.

(To be continued.)

UNDERGROUND RAILWAY FOR MARSEILLES.—The British Consul-General at Marseilles reports that the Municipal Council of that city has decided to undertake the construction of an underground railway, so much needed by the ever-increasing congestion of the streets. It is understood that no time will be lost in obtaining the necessary Government sanction and in proceeding with the work.

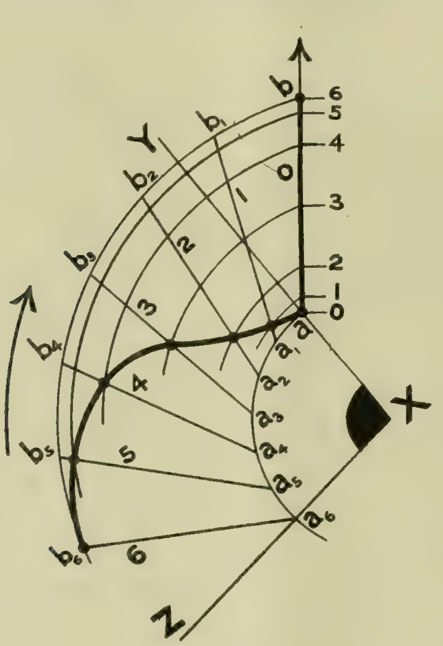
CAMS.

By W. E. Bennison, A.M.I.M.E.

(*Continued from page 35.*)

Standard lay-out for Spiral Cams.

Fig. 22 shows the standard lay-out for the spiral cam. For the sake of simplicity the follower is imagined to be a point. Let the point X represent the cam axis and the line *a b* the follower path. The cam rotates in a clockwise direction and while it sweeps through the angle, say, Z X Y the follower must move from *a* to *b*. According to the principles laid down it is necessary to revolve the line *a b* around the point X in an anti-clockwise direction, then to trace the *locus* of the point *a* as it moves along the follower path during the revolution. It is hardly necessary to describe the geometrical construction, which is simple, and can be followed from the diagram. The line *a b* revolves through the angle Y X Z, and if the line Y X be drawn through the point *a*



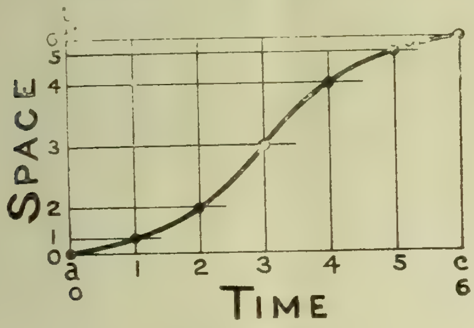
Cams.—Fig. 22.

the final position of *a* will be on the line X Z : a_6 b_6 represents the final position of the follower path. Between the first and last position of *a b* any definite number of intermediate positions are drawn; they must be equidistant because the cam is supposed to sweep through equal angles in equal times. In the present instance six equal divisions are taken, which means seven positions of *a b*, including the original one. The lines representing these various positions are numbered 0 to 6. To trace the motion of the follower along its path the line *a b* must have the same number of points marked on it as there are positions of *a b* : in this case seven points, including the first and last, with six spaces between: the points are numbered 0 to 6 : they need not necessarily be equidistant from each other, but are spaced according to the kind of velocity to be given to the follower; the spaces, however, represent equal times, that is, the times taken by the follower in traversing the space between every adjacent pair of points are all equal. Thus, while the follower path moves from its position *a b* to position a_1 b_1 the follower moves from 0 to 1 along *a b ;* while the follower path moves from position a_1 b_1 to position a_2 b_2 the follower moves from 1 to 2; and so on until at the end of the stroke while the follower path revolves from position a_5 b_5 to position a_6 b_6 the follower moves from 5 to 6, which is the point *b*. All that requires to be done now is to turn the points of the line *a b* into their respective follower path position by drawing arcs through them about the axis X : thus through the point 1 on *a b* describe an arc about the point X cutting the follower path position a_1 b_1 ; through the point 2 describe an arc cutting the follower path position a_2 b_2 ; and so on to the point 6, the arc through which will pass through the point b_6 previously determined. These arcs may carry the same numbers as the points through which they pass. The intersection of each arc with the follower path position of the same number will be a point on the curve. A curve drawn through all these intersections will be the true cam curve. The smaller the divisions, and therefore the greater the number of points taken, the more accurate will be the curve.

The angle Z X Y will be called the cam angle, that is the angle through which the cam revolves in order to move the follower from one end of its path to the other. The angular distance between any two adjacent positions of the follower path is a definite sub-division of the cam angle and is equal to $\frac{\text{cam angle}}{\text{number of divisions.}}$ The cam angle is not the same as the angle subtended by the cam curve, as a glance at Fig. 22 will show, though in special cases these two angles may be equal. Note should be made of this point because, simple though it seems, error is frequently made in laying out cams by assuming these two angles to be the same.

It remains to be shown how to correctly mark off the points on the follower path *a b* to give the required velocity to the follower. Sometimes this can be done quite easily, as for instance, when the follower moves through equal spaces in equal times, in which case the points are equidistant from each other. Other cases are more complex, and for these it may be necessary to construct a space-time curve. In this the spaces travelled by the follower are plotted against the time taken in moving through those spaces. Such a curve is shown in Fig. 23. In this diagram the ordinates represent spaces and the abscissæ times. The total height of the diagram is made equal to the length of the follower path, and thus the length of any ordinate equals the distance the follower has travelled at that point of the curve. The times are not measured in seconds but in angular movements of the cam : the cam angle, or a sub-division of it, is taken as the unit of measurement. In practice the abscissa *a c*, or base of the diagram, represents the cam angle, measured in circular measure : it is convenient to take for measuring an arc whose radius is equal to the distance between the axis and the follower in its mean position. The base line *a c* is divided into as many equal spaces as there are divisions of the cam angle in Fig. 22 and ordinates are drawn from the end of every space. In the present instance there will be six spaces and seven ordinates, the first ordinate being the vertical line *a b* which may be taken to represent the follower path. The ordinates are numbered 0 to 6. The distance

between any pair of adjacent ordinates represents the angular distance between any adjacent pair of follower path positions in Fig. 22, or rather the time taken by the cam in revolving through that distance. As mentioned before, the length of each of these ordinates will give the distance travelled through by the follower at the particular time represented by the position of that ordinate. If the intersections of the ordinates with the curve are projected horizontally into the line *a b* these projections give the required points, and they can all be transferred to the follower path proper on



Cams.—Fig. 23.

the cam diagram. The space-time curve is, of course, plotted out according to the velocity it is intended to give to the follower at every portion of its stroke. The velocity is equal to the space divided by the time, which is the slope of the curve; the velocity therefore varies directly as the slope of the curve. An inspection of Fig. 23 shows that in this particular case the velocity increases to the centre of the stroke and then decreases.

The space-time curve when applied to a cam is usually called the displacement curve or base curve of the cam.

(To be continued.)

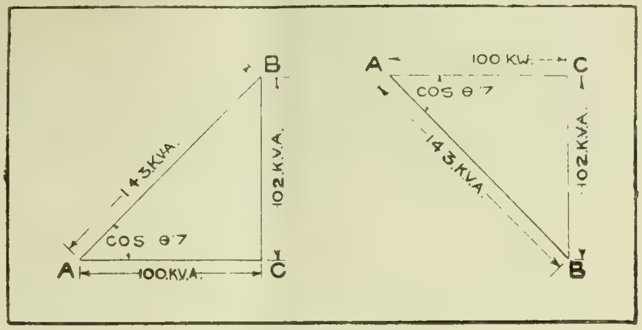
POWER FACTORS.

By F. Ashton.

(Concluded from page 47.)

Electro-static Condensers.

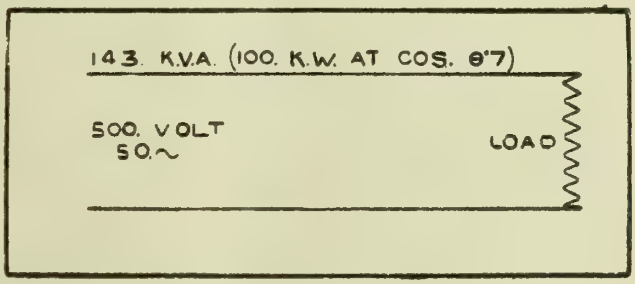
Electro-static condensers, such as Helsby condensers, may also be employed for power-factor correction, for it is well known that when such condensers are connected to an alternating-current system they draw a leading current. The advantages of condensers is that they can be supplied in small units, and can be connected to any portion of a system that gives a low-power factor, and can be switched in and out of circuit as occasion demands. For example, a condenser can conveniently be connected across the terminals of a large induction motor, so that the wattless current is confined to this local circuit. Another advantage of electro-static condensers is that they have no moving parts. An electro-static condenser corrects the power factor in exactly the same way as an overexcited synchronous motor, and to arrive at the capacity of a condenser necessary to meet a specific case it is first necessary to find the value of the lagging component, and then to select a condenser that gives a corresponding leading component. The procedure will be clear from Fig. 7, where the components of a total load of 143 kilovolt amperes are shown on the left. A C is the energy component, B C the wattless component, and A C the total apparent load. The values of these components are 100 kilowatts, and 102 and 143 kilovolt



Power Factors.—Fig. 7.

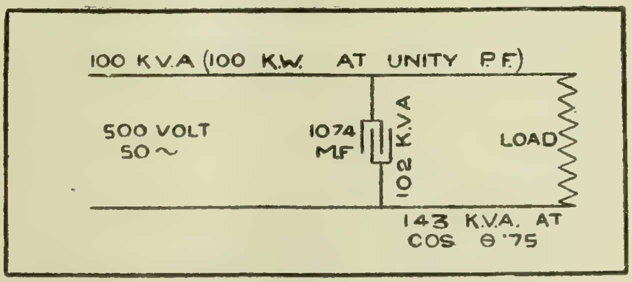
amperes respectively. The power factor is obviously $\frac{100}{143} = .7$

To raise the power factor to unity it would be necessary to use a condenser capable of giving a leading component of 102 kilovolt amperes, as



Power Factors.—Fig. 8.

shown on the right of Fig. 8. Let it be assumed that the circuit to which the condenser is to be connected is a single-phase one; that the voltage is 550; and the periodicity 50 cycles per second. Fig. 7 shows that to neutralise the lagging component of 102 kilovolt amperes, a corresponding leading component is required, as shown on the right. The



Power Factors.—Fig. 9.

capacity needed to produce this component is found from—

$$\text{Capacity in microfarads} = \frac{\text{K.V.A.} \times 10^9}{2\pi n \times V^2}$$

where n is the periodicity, and V the voltage. We may therefore write

$$\frac{102 \times 10^9}{2\pi \times 50 \times 550^2} = 1{,}074 \text{ microfarads.}$$

The conditions before and after the condenser has been added to the circuit are shown in Figs. 8 and 9 respectively. In the former case the entire circuit, including the generator windings, has to deal with a load of 143 kilovolt amperes, whereas in Fig. 9 the part of the circuit to the left of the generator only has to deal with 100 kilowatts. The generator and mains are therefore free to deal with a heavier load than before. On single-phase circuits the whole of the capacity is connected across two of the mains, as shown, but on three-phase circuits the capacity is divided into three equal parts, and each part is connected across one of the three phases.

(*Concluded.*)

THE ENERGY LIBERATED BY BOILER EXPLOSIONS.

In an article in the *Power House* on the above subject, Mr. T. H. Fenner, Editor *Marine Engineering*, points out that the whole catastrophe takes place in too short a time to permit of any detailed observation, and the unfortunate party in close proximity rarely has the opportunity of relating his impressions, at least on earth. However, our knowledge of the forces involved gives us a pretty fair idea of what happens, and thus we can explain the phenomenon with some degree of accuracy.

In the first place, it must be clear to everyone that the rupture precedes the explosion, and is the cause of it. The explosion does not cause the rupture.

Let us consider for a moment just what we have in the way of potential energy confined in the interior of the boiler.

Suppose we have a 72-in. diameter horizontal return tube boiler, with 72 four-inch tubes, and 18 ft. in length. The cubic capacity of the interior, deducting the space occupied by the tubes, will be roughly 395 cubic feet. The space above the water level, assuming the water to be carried at half glass, a fair working height will be represented by a segment 14-in. high, and the full length of the boiler. This will be equal to a volume of 69 cubic feet.

We have, therefore, a volume of water of 326 cubic feet, and as a cubic foot of water weighs 62·5 lbs., the total weight of water contained in the water space will be 20,375 lbs. We will say, roughly, 20,000 lbs. to keep the members in round figures. Suppose for pressure we assume 1,250 lbs gauge.

In order to arrive at a computation of the energy contained in the boiler, we must study the subject of latent heat a little.

Whenever the physical state of a body be changed, such as a liquid changing to a gas, or a gas to a liquid, the change is accompanied by the addition or subtraction of heat, which is energy. For instance, when the liquid ammonia in a refrigerating machine is passed through the expansion valve from the condenser to the cooler, in order to change from a liquid to a gas, it extracts the necessary heat from the brine coils. This heat is not to be confused with temperature, which is a different thing. In the same way, water in changing into steam extracts the necessary heat from the fuel. In changing from steam back to water the heat is given up, either in doing work on a piston, or in heating the surrounding air, or is carried off by condensing water. By the first law of thermodynamics, "heat and mechanical energy are mutually convertible, and heat requires for its production, and produces by its disappearance a definite number of units of work for each thermal unit."

The British thermal unit is the amount of heat required to raise one pound of water one degree in temperature, and is equal to 778 foot pounds of work.

The heat applied to water to raise its temperature is called sensible heat, as it is apparent by the raising of the temperature as shown by the thermometer. The heat applied to water to change it from water at 212 deg. to steam at 212 deg. is called latent heat. That is, the heat has been supplied to the water to change its state without raising its temperature, but has increased its energy by a definite number of foot pounds corresponding to 778 foot pounds for every unit of heat added.

To change water at atmospheric pressure to steam at atmospheric pressure and 212 deg. temperature, requires the addition of 966 units of heat, and the total heat contained in the water will be 1,146 thermal units.

As the pressure is raised the total heat is raised, but the relation between latent and sensible heat does not remain the same. The amount of latent heat decreases and the temperature increases, till at 125 lbs. gauge the total heat is 1189·5, the latent heat is 865·5, and the temperature 352·8, the quantity of heat above 32 deg. to raise the water to the new boiling point being 324 deg., instead of 180 deg. at the atmospheric boiling point of 212 deg. The total heat is affected slightly by the specific heat of water, which varies with temperature and pressure.

Specific heat, like specific gravity, is used to compare properties of different liquids with water. Water at 62 deg. has a specific heat of one, and above and below that the specific heat increases. For instance, one unit of heat is required to raise one unit of water one unit of temperature from 62 deg. to 63 deg. Fah., while to raise the same unit of water one unit of temperature from 32 deg. to 33 deg. would take 1·0094 units of heat, and from 320 deg. to 321 deg. would require 1·0285 units of heat.

To come back to our boiler. We have a quantity of water and a quantity of steam contained in one vessel.

The steam occupies 69 cubic feet, and the weight of a cubic foot of steam at 125 lb. gauge is ·316338 lb. Multiplying this figure by 69 gives us 21·82 lb.

Total heat of steam at 125 lb. gauge pressure is 1189·55 B.Th.U., and this figure multiplied by 21·82 represents the total heat in the steam. This product is 25955·98, say, 25956 B.Th.U.

In the water space of the boiler we have 20,000 pounds of water at a temperature of 352·82, corresponding to a total amount of heat above 32 deg. of 324·003. (The discrepancy shown by this latter figure, as compared to the result of subtracting 32 from 352·82, which would give 320·82 instead of 324·003, is due to taking into account specific heat).

$324·003 \times 20,000 = 6480060$ B.Th.U.'s in the water.

Now, supposing a plate gives way, what occurs? The water in the boiler is suddenly reduced from a pressure of 125 lb. to atmospheric pressure, and the

steam in the boiler likewise. Now, at atmospheric pressure, the total heat in steam is only 1,146 B.Th.U.

We have available in the boiler a total quantity of heat amounting to 25,956 B.Th.U. contained in the steam, and 6,480,060 contained in the water, altogether 6,506,016 B.Th.U.

The water being released of its confining pressure, will flash into steam, absorbing heat to do so. There is sufficient heat present to change 5,655 lb. water into steam at atmospheric pressure, and as steam at atmospheric pressure occupies a volume 1,646 times that of the water it is generated from, the whole of this energy will be available for removing obstacles to its expansion. Assuming that only 5,000 lb. of water changes into steam, we have a total heat energy of $5{,}000 \times 1146{\cdot}6 = 5{,}733{,}000$ B.Th.U. Each of these is equivalent to 778 foot lb. energy. Therefore, we have a force of $5{,}733{,}000 \times 778 = 4{,}460{,}274{,}000$ foot lb. Dividing by 2,000 for foot tons we get 2,230,137 foot tons.

Allowing the force to be in operation ten seconds, the horse power developed would be 810,834.

Supposing the boiler weighed 18,000 lb. and the water not vaporised weighs roughly 14,000 lb., say a total weight of 32,000 lb., if the total energy could be concentrated on raising this weight it would be sufficient to lift it a height of 26 miles.

However, the energy is dissipated in other ways. Part of it is utilised in tearing the plates apart, and again there is an enormous air resistance against the irregular shaped masses of steel tending to stay their progress.

Suppose it started at an initial velocity of 3,000 ft. per second, as a projectile is fired from a long-range gun, leaving the ground at an angle of say 60 deg., then the range would be about 80 miles, equal to the best efforts of our friends, the enemy.

Therefore, in the light of the foregoing, avoid explosions.

ENGINEERING PROFITS.

There is a well known proverb anent killing the goose which lays the golden eggs, and there is a tendency in present discussions upon the industrial future which points the moral of the proverb.

Three factors are always present in the industrial equation—producer, management and customer—exploitation in the sole interest of any one of these is indefensible, throwing the nicely adjusted machine out of balance, thus causing friction and loss. The correct apportionment of value between these three interests is vital to combined industrial success free from internal trouble and financially solvent.

If the customer obtains sweated returns in the article made, the nation at large does not benefit in the long run: if the employer obtains inordinate profit he penalises both labour and customer; if labour forces uneconomic wages, it may, if the price to the consumer be a fixed quantity, destroy the industry. To ensure high wages, adequate profits and low price, means efficient method, improved machines and large output.

The poise and balance of the industrial machine depends upon a number of things, and it is easily put out of gear from a variety of causes; this delicacy is often not realised as it might be by those who earn their subsistence as a tooth in one of its wheels. There has as yet been found no better incentive to enterprise than the opportunity to earn profit, and this is quite a legitimate return upon investment, hazard, and risk. It has been pointed out that in engineering industry, invested capital is represented by solid and tangible assets; for this security the dividend upon capital when averaged over the entire business is relatively small, while the industry (*vide* Board of Trade returns) pays the highest average wage of any national activity.

Engineering effort is the principal key industry; it underpins nearly all other manufacture; the national industrial machine is carried on the back of the metal working trades. This gives it an enhanced importance, especially when it is remembered that it is not a luxury trade, but is second only to agriculture as the creator of real wealth by increasing resources and multiplying human effort.

It is, in effect, the supreme lever in the hands of man with which the world's concerns are effected. The modern universe without the engineer is quite unthinkable, for nearly all those matters which make up modern civilisation are provided directly by the work of the modern engineer. Curiously enough, the margin known as profit is surprisingly small, if this be considered as a weekly profit per employee. Taking this as the fee the workman pays, or the commission charged him for finding work for his hands, it is as a percentage, not inordinate, that is if the entire profits of the whole industry are divided by the total number of men.

The exact figures are not available, but it would not be surprising to find that an increase in wages of less than 10 per cent would entirely wipe out all the profits at present made, if the extra burden could not be passed on to the customer.

Anyone interested, employed by a limited public company, can do their own division, finding the average profit of the last 10 years, and dividing by the average employees for this period; only by such figures can it be realised how small is the working margin, or exactly what profit per capita is made.

DR. SALEEBY ON THE SMOKE NUISANCE.

Speaking before the Eighth Annual Conference of the British Commercial Gas Association, in London, on October the 28th, Dr. C. W. Saleeby, F.R.S. (Edin.), said that though we had at last a Ministry of Health it had not been able to do very much. But it had published ideas of what it proposed to do in the future. Its latest production, he said, waving a cumbrous volume before his audience, indicated the various ways in which it was going to work to create healthy people, but there was little reference to the question of smoke. Much was said about pure water, but little about pure air. That was characteristic of this country because we had been brought up in the smoke and were satisfied with it.

We thought of coal as a fuel, but a chemist would tell us that coal is a treasure house of a thousand valuable things, and that to burn it is barbaric folly. One could imagine a barbarian coming along and seeing the British Museum with all its treasures, and being ignorant enought to say:

"Here is something that will burn; let us make a fire." To burn crude coal and destroy thereby its latent treasures is, said Dr. Saleeby, just as short-sighted and criminal as to burn any other repository of irreplaceable wealth.

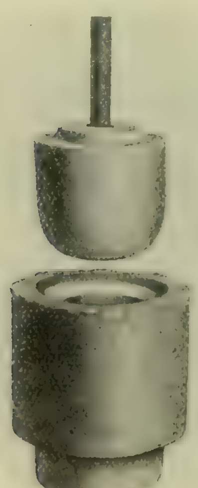
We should extract from coal the dyes and drugs, and other valuable properties which it contains, and burn the residue as fuel. He advocated the increased use of gas, the spirit of coal, in place of crude coal for all domestic and industrial purposes, and urged that this question should be fully considered in dealing with the projected housing schemes.

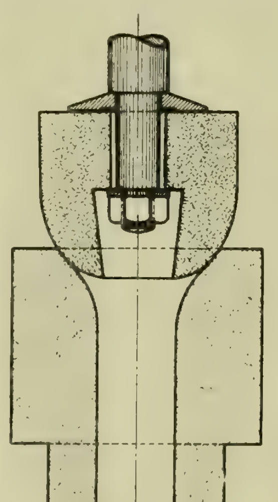
GRINDING FIRE-CLAY NOZZLES FOR STEEL POURING LADLES.

Fire-clay nozzles are used in steel foundries in the bottom of steel pouring ladles. With a graphite stopper they are used for retaining the molten metal. The stopper must of course fit perfectly into the clay nozzle in order to ensure a complete cutting off of the steel when a casting has been poured.

In use the nozzle becomes slagged over, destroying the fit of the plug.

It has been found by a number of concerns that grinding wheels can be very nicely utilised for grinding the seat in new nozzles, and also for grinding





out the slag in nozzles which have been used. The wheel is formed to the same shape as the graphite plug, and mounted on a vertical spindle so that the wheel can be fed down into the nozzle. The nozzle is held stationary.

Alundum wheels in grain 20, grade 0, have been found very satisfactory; and crystolon wheels in grain 30, grade N, are also successfully used.

The illustration shows a wheel ready for use, and also the nozzle and graphite stopper. The drawing shows the wheel and nozzle in cross-section, illustrating the countersink necessary for proper mounting and the seat ground.

Trade Items, Notes, &c.

Russian Engine Oil.—Messrs. Sterns Ltd., Finsbury Square, London, inform us that they are now in a position to offer deliveries of genuine Russian No. 1 engine oil. This oil has, of course, not been procurable since the early days of the war, and although our readers will have had to make do with substitutes, they will undoubtedly welcome the intelligence that they can again secure supplies of the Russian article. At present, owing to the large demand, the firm's stocks are limited, but they hope to be able to continue regular supplies.

Commercial Travellers on Naval Ships.—An interesting departure was announced by the Parliamentary Secretary of the Overseas Trade Department, Sir Hamar Greenwood, M.P., at a luncheon given on October 29th by the Association of British Chambers of Commerce. Owing to the difficulty experienced at the present time in securing berths in the ordinary passenger boats, he approached the First Lord of the Admiralty, Mr. Walter Long, with the request that every warship sailing for ports abroad should be allowed to carry a certain number of commercial travellers and other representatives of British firms. Mr. Long has personally agreed. "It now remains," Sir Hamar Greenwood continued, "for the First Lord of the Admiralty to convince the Sea Lords of the Board of Admiralty that they can serve this country in no better way than by carrying commercial travellers to the uttermost parts of the earth."

State Purchase of Hydro-electric Works.—The Horahora hydro-electric works erected a few years ago by the Waihi Gold Mining Company, and described as one of the best plants in New Zealand, have been purchased by the Dominion Government. The company's own maximum demand is 4,000 H.P. The remainder, 8,000 H.P., will be distributed by the Government throughout the Waikato and adjacent districts as far as Auckland. The latter is slightly over 100 miles from Horahora. The Government had the right to take this property at any time without payment of goodwill at a valuation fixed by agreement or arbitration, and it is said that they have acquired it at the absolute cost price, £212,500.

Lubricating Oils from Naphthaline.—For lubricating delicate machines use is generally made of neat's foot or bone oil, to which more or less mineral oil is added as required. It has now been recently found that in place of such oils hydrated naphthaline, which is being made by a Berlin firm by their own patent process, can be employed with excellent results. By this such products are meant as are obtained from the known (resulting from the distillation of coal) carburetted hydrogen naphthaline by treatment with hydrogen, such as tetra-hydro-napthaline, for instance, and other stages up to deka-hydro-naphthaline. These preparations are especially suitable for lubricating delicate machine tools, watchmakers and scientific instrument makers' machines, textile machinery, and the like. They can be used either alone or else added to other oils. If emulsified with water they can also be used as boring oils.

Difficulties in the German Iron Industry.—Reports from Dortmund state that orders are pouring there, and there are splendid opportunities for export business, as every market seems to be absolutely rapacious for iron and ironware, yet in spite of this foundries and mills are compelled to dismiss hands and work half time due to the great scarcity of coal combined with strikes. The situation has been rendered all the more acute by the strike of the lime works at Hönetal, so that the blast furnaces cannot get any lime, and consequently the production of pig iron has also declined. Unless something is done soon to increase the production of coal, things will look very serious in the Fatherland.

Peat Fuel for Locomotives.—Peat powder is now being successfully used in Sweden as a substitute for coal for the direct firing of locomotives. The Swedish Government has now erected a peat winning and powdering mills at Hästhegen Moor, from which about 20,000 tons of peat powder will be secured from every 220,000 cubic metres of peat. The peat is first of all dried till it only contains about 40 per cent water; it is then crushed and again dried in an oven until the content of water has been reduced to 12 or 15 per cent. It is said that with 1·5 kg. of peat powder the same amount of steam can be generated as with 1 kg. of coal of 7,000 calories.

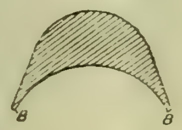
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts o Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

TURBINES.

122,019.—H. E. YARROW, Scotstoun, Glasgow.—Jan. 9th, 1918. Turbine blades with sharp edges are strengthened by rounding

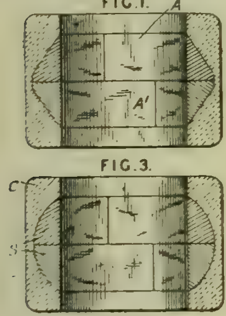


the edges as shown at B for a short portion of their length at the end secured to the drum or casing.

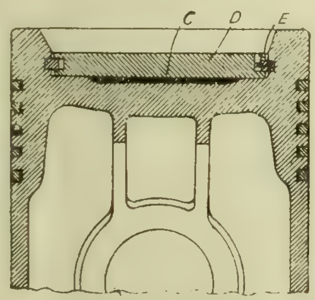
STUFFING-BOXES.

122,089.—W. R. BELDAM, 1A, New London Street, London.—Mar. 22nd, 1918.— A modification of the invention described in the parent Specification consists in replacing the metal ring or rings by rings A, A1, Fig. 1, of a hard, non-metallic material such as vulcanite, wool, or fibre. A further modification consists in the use of a pair of hard metallic or non-metallic rings B, Fig. 3, having a spherical periphery embraced by a wrapping C of soft non-metallic packing.

FIG.1.



Patent 122,089.



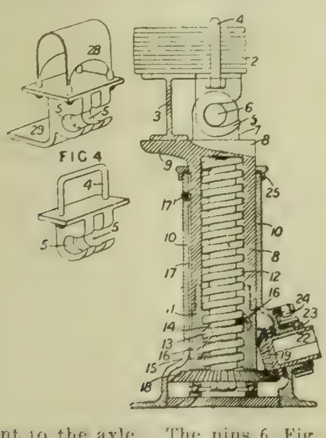
Patent 122,162.

PISTONS.

122,162.—NORTH BRITISH DIESEL ENGINE WORKS LTD., South Street, Whiteinch, and J. C. M. MACLAGAN, 14, Park Corner, Westland Drive, both in Glasgow.—Oct. 28th, 1918.—The piston of an internal-combustion engine is provided with a readily detachable plate to prevent damage from overheating. The piston shown has a flared recess in the crown in which is secured by a split ring E a renewable plate D. A layer C of asbestos or other insulating material may be placed under the plate.

LIFTING JACKS.

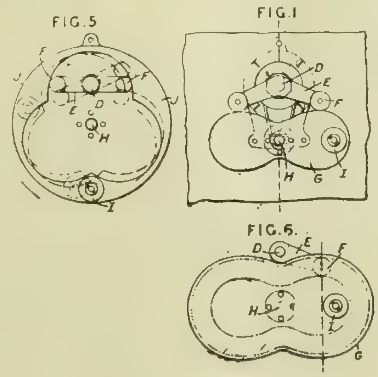
122,216.— F. L. RAPSON, Childwell Hall, Liverpool.— Dec. 17th, 1917.—A lifting-jack for raising motor road and other vehicles is detachably connected to the vehicle by pins 6 which engage one or more hook members 5 secured to the axle or to the vehicle



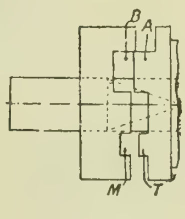
spring 2 adjacent to the axle. The pins 6, Fig. 1, are formed on an extension 7 of a sleeve 8 mounted in a casing 10 and fixed at its lower end to an internally-threaded nut 11 which is engaged by a screw 12 rotated through bevel gears 18, 19 by the movement of a handle inserted in the socket 22. The handle is preferably of **T**-shape, and may be constructed to fold up. Anti-friction balls 15 are held between semi-circular grooves 13, 14 formed in the upper side of the thread on the screw 12 and in the lower side of the thread on the nut 11, respectively. The outer ends of the groove 14 are connected by a channel 16 which permits circulation of the balls. The sleeve is guided by a screw 17¹ which projects into a slot 17. Accidental lowering is prevented by a pawl and ratchet 24 23. An annular cover-plate 25 renders the casing 10 dust-proof. An extension 9 on the sleeve 8 takes under the axle 3 when the jack is in operative position. The plate carrying the hooks 5 is secured to the spring 2 near the front axle by a **U**-shaped bolt 4, Fig. 4, and to the rear axle by a strap 28, Fig. 5. In the latter construction, the projection 9 on the jack bears against an extension 29 of the hooks. In a modification, the jack is secured to the vehicle by a head on the jack or vehicle which slides in rebates in a plate on the vehicle or jack.

PUMPS.

122,265.—VICKERS LTD., and H. A. SAVAGE, Vickers House, Broadway, Westminster,—Jan. 24th, 1918.—In means for operating pumps of the oscillating vane type, particularly such as are used for pumping petrol from main to auxiliary tanks on areoplanes, a hand-operated rotary cam engages a lever on the pump shaft so as to cause two or more oscillations of the shaft for one revolution of the cam. Fig 1 shows the pump-shaft D fitted with a double-lever E having rollers E bearing on a cam G which is rotated about the spindle H by means of a handle I. Fig. 5 shows a modification in which the pump-lever E engages inside a three-lobed cam J, and Fig. 6 a single lever E operated by a grooved cam G.



Patent 122,265.



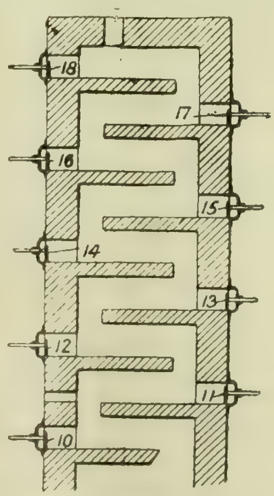
Patent 122,348.

CLUTCHES.

122,348.—T. WILLIAMS, 133, Woodland Road, Barry Dock, Glamorganshire.—May 16th, 1918.—Claw clutches have in each member one tooth A and one recess B longer circumferentially and projecting parallel to the axis beyond the other T, M so that the members must always engage in the same relative positions.

FURNACES.

122,712.—O. F. S. CARLSON, Ljunga Verk, Ljungaverk, Sweden.—Feb. 7th, 1918.—In furnaces with superposed hearths or shelves, the implements 10—18 for stirring and feeding the material from shelf to shelf are actuated in succession from below upwards, either

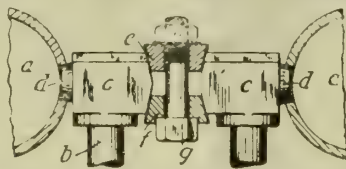


in groups or throughout the whole furnace, so that the material may remain for a longer time on each shelf. The implement which operates on the lowermost shelf of the whole furnace or of any one group of shelves is first actuated and then the subsequent implements upwards through the whole furnace or

through any group of shelves the order of the groups being shifted if necessary. The application to electrically-heated furnaces, as well as to those heated by ordinary firing is mentioned, and the method of opertion may be applied in effecting reactions between solid substances or solid or gaseous substances, or in dyeing.

STEAM SUPERHEATERS.

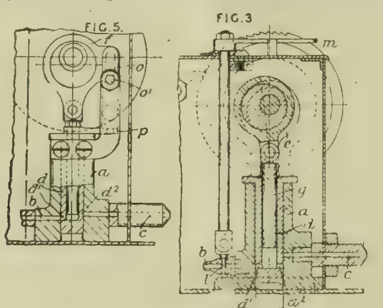
122,722.—J. GORDON, Queen's House, Kingsway London.—Aug. 12th, 1918. A U-tube or like superheater element *b* is connected to parallel headers *d* by means of double wedge-pieces *e, f,* which



engage with inclined surfaces on blocks *c* fitted on the ends of the element. By screwing up a nut on the bolt *g* passing through the wedge pieces, the blocks are forced apart so as to tighten the joints *d* at the openings in the headers.

RECIPROCATING PUMPS.

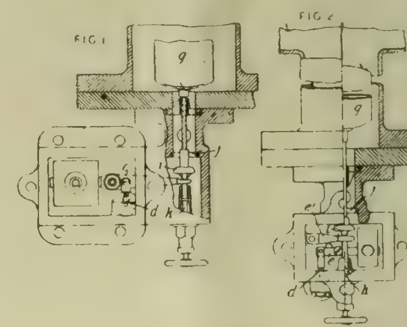
122,924.—G. E. VENABLES, Deane Bank, and J. S. BLACKMORE, Oak Bank, Elworth, both in Sandbach, Cheshire.—Feb. 13th, 1918. A pump for oil, etc., comprises a fixed barrel *a*, with suction and



delivery ports *b, c* at different levels, an inner reciprocating cylinder *d* closed at one end and provided with suction and delivery ports *d1, d2* in the same plane and adapted to register alternately with the ports *b, c* and a plunger *g* reciprocating in the cylinder *d*.

STEAM TRAPS.

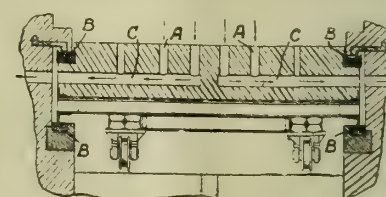
122,874.—R. H. VENNELL, 51, Hallewell Road, Edgbaston, Birmingham.—Jan. 31st, 1918.—In a steam trap having a discharge valve, as *d*, Fig. 1, operated by a float and counterbalanced lever *e*, the float *a* is arranged independent of or not connected with the lever *e* and is adapted to impose its weight thereon, in its descent



in order to close the valve *d*. As shown in Fig. 2, a compound lever *e* and is adapted to impose its weight thereon, in its descent provided with a valve *i* operated by a screwed spindle *k* to close the opening *j* for permitting access to the interior of the trap for testing whilst still under steam.

FURNACES.

122,928.—E. C. R. MARKS, 57, Lincoln's Inn Fields, London.—(Soc. Anon. Italiana G. Ansaldo and Co., Genoa, Italy.)—Feb. 16th, 1918.—



A removable hearth for a heating furnace is provided with openings A and transverse passages C for the escape of the heating gases, and with two seals B, B between its sides and the side walls of the furnace, one above and another below the passages.

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CONTENTS.

EDITORIAL.

OIL-FIRED BOILERS.

THE employment of oil as fuel for the boilers of battleships and steamers is by no means new, and the great number of additions now being made would seem to prove that the results have been highly satisfactory. One does not, however, come across many instalations of oil-burning plants in industrial work, but there are indications that expansion in this direction is imminent.

The reasons are not far to seek. Coal, during the past few years, has advanced considerably, in spite of recent reduction. Labour is difficult to get and costly to maintain. The comparison between coal and oil as fuel for steam raising will, in many cases, show a case in favour of the latter. Particularly is this the case where large ranges of boilers are used, because, although the cost of the two fuels may be very near, the enormous saving in labour more than turns the scale in favour of oil.

It is a comparatively easy matter to adapt a boiler to the new conditions. The removal of the grates—which can be stored against a possible return to coal—or covering them with fire brick, and the installation of a blower is all that is necessary. Recently, the writer had the opportunity of inspecting an oil-burning boiler plant at work in America, and obtained some figures that may prove of interest.

The boiler pressure was 160 lb., and one man looked after eight boilers, two of which were idle at the time of inspection. Special automatic regulating devices are being supplied to the boilers, which reduce the oil supply if the pressure exceeds a certain limit, and increases it if the pressure falls below the limit set.

The following table gives the comparative costs of oil and coal at this mill.

COMPARATIVE COSTS OF COAL AND OIL AS BOILER FUELS AT COTTON MILL, LORRAINE MANUFACTURING CO., PAWTUCKET, R.I.

(1) Cost based on coal and labour figures of August, 1915.

(*a*) Coal mixture of 87·6 per cent of New River and 12·4 per cent of buckwheat. Heating value of mixture 13,593 B.Th.U. per lb. and boiler efficiency 65 per cent. Price, 4·123 dollars per ton of 2,200 lb.

(*b*) Coal for banking fires taken as 3,000 lb. of New River coal per boiler per week for 25 weeks.

(*c*) Fuel oil at 1·10 dollars per barrel of 42 gallons; 18,260 B.Th.U. per lb. and 8·005 lb. per gallon. Boiler efficiency 79 per cent.

(*d*) Labour per week as follows:

	Coal.	Oil.
1 Coal passer	$ 9·00	$ ·00
1 Day fireman	13·50	13·50
1 Night fireman	12·00	12·00
Total per week	$34·50	$25·50

(*e*) Cost for handling ashes 3·00 dollars per week. Total cost per 100,000 lb. of water evaporated from and at 212 F., assuming an evaporation of 2,000,000 lb. of water per week:

	Coal.		Oil.
Fuel	$20·582	...	$22·010
Banking fires	·379	...	—
Labour	1·725	...	1·225
Ash-handling	·150	...	—
Total	$22·836	...	$23·235

Difference in favour of coal, 1·75 per cent.

(2) Cost based on coal and labour figures of June, 1916.

(*a*) Coal mixture having an average heating value of 13,978 B.Th.U. per lb., and boiler efficiency 65 per cent. Price of mixture 5·078 dollars per ton of 2,240 lb. This price is based on New River at 4·75 dollars on cars and buckwheat at 3·36 dollars on cars.

(*b*, *c*, *e*) as above.

(*d*) Labour 15 per cent higher than in August, 1915. Total cost per 100,000 lb. of water evaporated from and at 212 F.:

	Coal.		Oil.
Fuel	$24·212	...	$22·010
Banking fires	·426	...	—
Labour	1·984	...	1·409
Total	$26·772	...	$23·419

Difference in favour of oil, 12·52 per cent.

An increase of 0·10 dollars per ton in the price of coal will change this difference by 1·5 per cent.

It will be noted that the cost of coal is given at 4·123 dollars a ton. Since the date of the test, coal has risen to over 5 dollars a ton—in fact, nearly 6 dollars, so that, taking the difference as 1·3 per cent for every 0·10 dollar rise in the price of coal, the difference in favour of oil is now more marked than ever at this particular mill.

THE OPERATION OF DIRECT-CURRENT ELECTRIC MOTORS.

By E. Austin.

(*Concluded from page 64.*)

Breakages in the Winding.

In the event of a motor failing to start when the current is switched on to it, the probability is that in some part of the circuit there is a broken connection. If there is a break in the field winding of a shunt-wound motor, the machine will draw a heavy current, which will blow the fuses or open the circuit breaker. Whether or not there is a break in one of the field coils can readily be ascertained by connecting the field circuit to the supply with an ammeter in circuit, and if no reading can be obtained, it may of course be concluded that the circuit is incomplete. To ascertain which of the coils contains a broken wire, a voltmeter may be connected across the individual coils one after the other, as shown by the dotted lines in Fig. 3, and when the faulty coil is reached the voltmeter will register the pressure of the supply. The same test may be adopted to ascertain whether one of the coils contains a short-circuit; but in this case a reading will be obtained when connecting the voltmeter across every coil, the faulty coil, however, giving a lower reading than the other coils, owing to its lower resistance. A short circuit in one of the field coils may not prevent a motor working, but it may easily cause it to work very unsatisfactoryily. The machine may spark excessively and attain a very undesirable working temperature. If a field coil is found to contain a short-circuit, or open circuit, it must of course be rewound. Failure of the insulation between the field coils and iron frame of a motor, or between the armature windings and the iron core, may be detected with the aid of an insulation testing set, or by connecting one pole of the supply circuit to the iron frame work through a lamp or voltmeter whilst the other supply lead is connected to one terminal of the motor. In testing the armature for an insulation fault however, it is advisable to apply the second supply lead directly to the armature shaft, as the oil film on the bearings

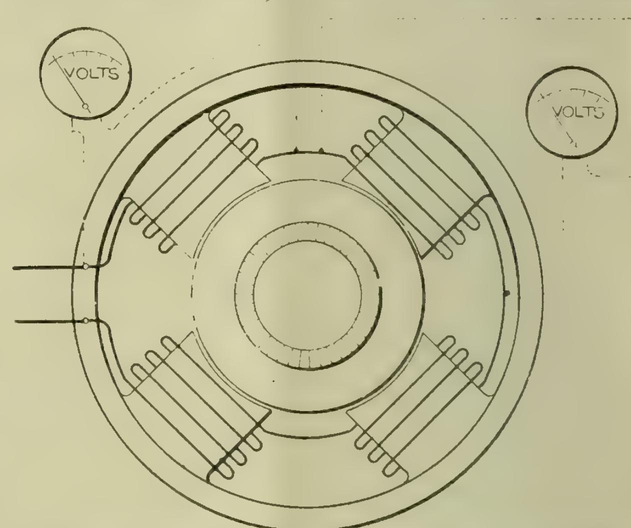


Fig. 3.—Method of Locating Faults in the Field Windings.

is liable to act as an insulator. Of course, if the lamp lights, or the voltmeter show a reading on being connected in the manner described, the insulation is at fault.

Armature Windings.

Armature faults are usually more common than faults in the field windings, owing, of course, to the fact that the armature windings revolve and are consequently more liable to be subjected to shock and vibration. Armature windings, like field windings, may contain open circuits, short circuits, or the insulation may break down between the coils and core in the manner already mentioned. Short circuits in armature coils or between commutator segments, can be located by passing a current through the armature and by measuring the pressure drop between adjacent commutator bars. Obviously, whilst this is being done, the armature must remain at rest and the field circuit, or circuits, in the case of a compound motor, should be disconnected from the brushes. A low voltage will be sufficient to send the requisite current into the armature, for as the armature does not revolve it does not develop a back electromotive force, and the applied pressure

simply has only to overcome the ohmic resistance of the windings. The current should be about equivalent to the full load current of the motor, or a heavier current provided the windings are not overheated. The current may be derived from a low voltage accumulator or from the supply mains if a suitable series resistance be used Whilst the current is flowing through the armature windings, a voltage test must be made between each pair of adjacent commutator segments with the aid of a low reading voltmeter, each division on the scale representing about one-tenth of a volt. If it is found, on testing the voltage between the various commutator segments, that one particular pair of segments gives a zero or low reading, then it may be concluded that the coil connected to these segments is short-circuited, or that the segments are short-circuited. If, on the other hand, it is found, on applying the voltmeter leads to a pair of segments, that the instrument gives a considerably higher reading than obtained between other pairs of segments, then there is a break in the winding. If an armature contains a short-circuit, local heating results, and the coil that is at fault can often be located by feeling round the armature after the motor has been taken off load.

Connecting Up After Repairs.

In connecting up a motor after it has been taken to pieces for repairs, it is important to ensure that all the connections are correctly made. The field windings should be connected so that field magnets next to one another have opposite polarity, a convenient method of testing the polarity being to pass a small compass needle from pole to pole, when the needle should reverse every time it is brought opposite a magnet. In the great majority of instances the current in the series winding of a compound motor (Fig. 2) flows round the poles in the same direction as the current in the shunt winding, with the result that as the load increases the magnetisation increases. If, however, the series winding is incorrectly connected, the poles will be weakened instead of strengthened, and at times of heavy loads the speed will tend to increase instead of decrease, and bad sparking may result owing to the motor endeavouring to develop more power than it is capable of dealing with. Care must, therefore, be taken to see that the series winding connections are properly made, so that the main current flows round the poles in the same direction as the shunt current.

The Function of Interpoles.

Within recent years a great many motors have been fitted with interpoles, or as they are sometimes called, commutating poles. The interpoles usually consist of long narrow magnets placed between the main magnets, and their function is to counteract the reaction voltage of the armature coils. The current in the armature coils connected to the armature segments is reversed every time the segments pass under the brushes, and this reversal of current is opposed by the reaction voltage established in the coils undergoing commutation. The function of the interpoles, therefore, is to induce a voltage in the coils which counteracts the reaction voltage. Of course, the reaction voltage induced in the armature coils varies with the current the coils carry, and therefore the strength of the magnetism emanating from the interpoles must also vary with the current. The interpoles are, therefore, wound with thick wire, and the coils are connected in series with the armature, so that as the load increases the magnetism of the interpoles becomes stronger. When interpoles are fitted to a motor, there is one definite position for the brushes. This position is fixed before machines are dispatched from the makers' works, and provided the brushes are kept in this position and the machine is properly designed and constructed sparking troubles are not liable to arise.

(*Concluded.*)

INDUSTRIAL ART AS A NATIONAL ASSET.*

An American View.

Both in quantity and quality production, the value of a course of training in industrial art is destined to be an important factor in enhancing the value of finished goods. The subject is at present receiving special attention by a Department of the Board of trade in this country, and by the Bureau of Education in the United States of America.

In a pamphlet recently issued by the latter it is urged that America must turn from her quantity methods, and, through industrial art training, put the country's commerce on a quality basis.

"There are not three standards of good taste," the pamplet states, "one for the producer, one for the storekeeper, and a third for the person who buys the goods. Yet these three groups have in modern times each misjudged the others, because education has yet to standardise and inter-relate their interests and tastes." In this concise statement, it is claimed, is indicated a basic problem confronting commerce to-day, and the pamphlet, which is summarised below, has been written to explain what training in industrial art can do to help solve it.

Wages and Education.

While the activities of a nation depend upon its average ability, it is only through the training of the individual that the average can be changed. The comparison between the length of time the average hundred boys and girls remain in school and the incomes of the average American wage earners offers valuable suggestions:—

> Sixty-seven per cent leave school before completing the eighth grade.
>
> Sixty-eight per cent of our citizens earn less than 15 dollars a week.
>
> Thirty-three per cent of the students entering school complete the eighth grade.
>
> Thirty-two per cent of the workers of the nation earn over 15 dollars a week.

From those thus remaining in school are recruited the more highly skilled workmen and practically the entire body of the professions, including the designers, upon whom the entire fabric of American manufactures depends. Higher standards of workmanship and higher wages depend upon the training given in the industrial arts to those who form the

* *Board of Trade Journal.*

mass of workmen, and upon whose skill depends the carrying out of the designer's ideas. Ninety per cent of the people gain no technical education higher than the eighth grade. This means that 90 per cent of the workers between the ages of 16 and 23 have no technical training except that which they have "picked up" themselves.

Design as a Trade Factor.

The prosperity of the nation, the city, and village, as well as of the individual, depends upon the "turnover" of their products as sold in the stores not only of our own country, but in those of the entire world.

Next to competition upon the ground of price, which is the chief factor in the sale of goods, without other merit the competition for goods made attractive through superior design and durability shows the wisdom and need for our cities to take definite steps toward the establishment of industrial art schools.

These schools will in time increase the quantity and value of the manufactures of their cities and of the nation—

(1) By training the designers, workmen, and salesmen to sell superior products in the thousands of stores of their class.

(2) By training the buyers and users to discriminate between the ugly and the bizarre, and be able to choose and demand goods of merit.

Although education in art and industry can prepare us to make and choose wisely, whether we profit by this instruction individually or collectively, depends upon our own initiative: (1) as consumers demanding design and durability in exchange for a reasonable price; (2) as designers, firm in the standards we set, being guided by the principles of evolution rather than by the idiosyncrasies of fashion; (3) as workmen, taking pride in excellence of craftsmanship and feeling a share of responsibility for the output; (4) as salesmen, guiding the buyer through an intelligent and thorough understanding of the romance of goods and a sympathetic insight into the needs of the purchaser, resulting in an enlightened customer and a satisfactory sale.

Except the agencies of education in industrial art bring these different groups of people to have the same standards, there will always be an unbridged gap between them—resulting in the customer's inability to get the goods he desires, the designer's failure to follow any standard but the "fashion," and the manufacturer's inability to sell on any basis other than price.

From Bulk Trade to Quality Sales.

The commercial supremacy of the United States was largely reared upon the bulk disposal of raw or semi-finished materials. American natural resources, while vast, are not unlimited. In fact, according to the National Conservation Commission, "the known supply of high-grade iron-ore in the United States approximates 4,788,000,000 tons, which at the present increasing rate of consumption cannot be expected to last beyond the middle of the present century." This is an example of similar situations regarding other raw materials, particularly minerals.

We have been selling our resources on the bulk basis. It is said the United States sells 2,000 lb. of goods per 100 dollars, England sells 1,000 lb. of goods per 100 dollars, France sells 400 lb. per 100 dollars, and Germany sold 30 lb. per 100 dollars. Either we must turn from our quantity methods and, through industrial art training, put the nation's commerce on a quality basis, or we shall lose the opportunities and advantages which our fast-diminishing resources of raw materials offer.

There is no limit to the value that design and workmanship can add to the raw materials of the nation except that which is imposed by a lack of facilities for training the designers, workmen, salespeople, and consumers. The United States will not be able to increase the worth of its products toward the highest market values until it has more schools to train its people in the refinements of design and workmanship. The average extra dividend which skilled workmanship declares to a community is 59 per cent of the value of the finished product, the raw material being on an average worth 41 per cent of the selling price. Skill therefore adds to the wealth of a State on an average 144 per cent through a more efficient use of its raw materials.

GOVERNORS AND GOVERNING MECHANISM.

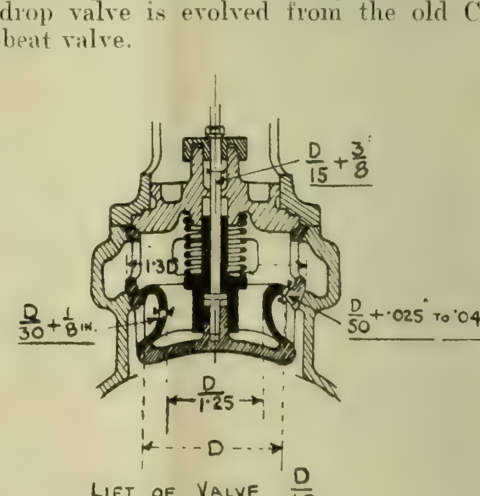
By A. Houlson.

(*Continued from page 36.*)

Drop-Valve Gear.

With the advent of superheated steam arose the necessity for a valve having no rubbing action on its seat, consequently the flat side and Corliss type of valves were superseded by the drop valve.

The drop valve is evolved from the old Cornish double-beat valve.



Governors.—Fig. 69.

Fig. 69 shows a double-seated drop valve of modern design.

The power required to lift a drop valve depends upon the width of the valve seats and the area of the spindle.

The lower face must pass through the upper valve seating, and, therefore, the outside dimensions of the lower valve seat must be somewhat less than the inside dimension of the upper seat.

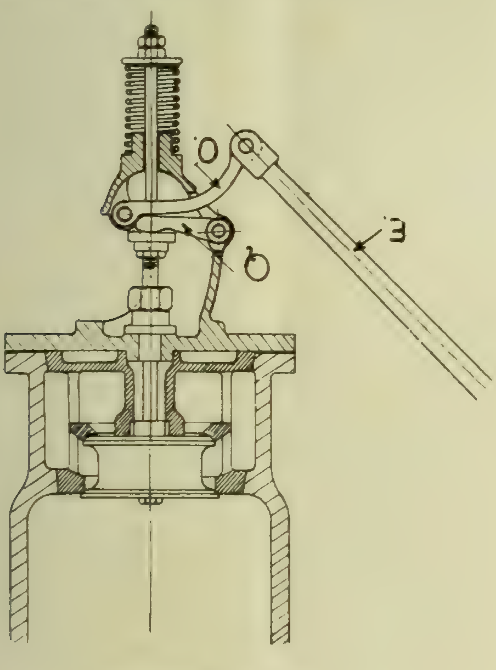
Considerations of durability apart, the seats would

be made a knife edge, for it would then be possible to make a valve almost in equilibrium.

In actual practice the seats vary in width from $\frac{1}{8}$ in. wide for valves 6 in. diameter to $^5/_{16}$ in. wide for valves 12 in. diameter, the diameter of the valve being taken at the outside of the smallest seat, and the width of seat being half the difference between the outside and inside diameters.

In any valve the seats are usually all made to the same width, and are bevelled to an angle of 45 deg., although recently flat seats are coming into favour. For low pressures and temperatures gun-metal valves and seats were satisfactory, but with high pressure or superheated steam, it is necessary to make both valves and seats in cast-iron. Further, the seat should be so designed that it may have a free expansion in the cylinder casting without straining.

In the design of drop valve gears it is well to bear in mind two characteristic features, the first that it is



GOVERNORS. —FIG. 70.

only for the instant the valve is lifted from its seat that there is much stress thrown on the gear, and the second feature that there can be no positive connection between the valve and the shaft which drives it.

With respect to the first point, it is evident that the gear must be made strong enough to withstand the heavy stress upon it at the instant of opening. Seeing that this is only momentary, it appears possible that at this instant the gear could be arranged to occupy a position in which it has a purchase upon the valve, whereby stress will be reduced, and the gear can be made light and compact.

If we consider the exhaust valve in Fig. 70, the eccentric rod E is connected to a rolling lever O which rolls upon the pallet Q. The valve is shown in the closed position, and the eccentric rod is at the end of the stroke and about to ascend. Half the motion of the eccentric will be occupied whilst the lever is suspended between the valve spindle and the eccentric rod, but after this the rolling lever will come in contact with the pallet. The first point of contact is near the valve spindle, thus giving the rod considerable mechanical advantage over the valve. As the rod continues its ascent, the point of contact travels away from the spindle. By the above action the momentary resistance offered by the valve is not seriously felt by the gear, and a sufficient lift is obtained with a small movement of the eccentric. The action carries with it another advantage in that the closing of the valve is rapid at the early part of its fall, but as it approaches the seat the velocity decreases so that the closing of the valve is very gentle and entirely without shock. Various other arrangements to effect the easy opening and closing of the exhaust valves are met with in practice. In some engines cams are employed to actuate the valves, and gradual opening and closing are obtained by a suitable contour, whilst in others the principle of the toggle joint is applied.

With respect to the second feature, that there can be no rigid connection between the driving shaft and the valves, it will be seen that this is inevitable from the fact that the closed position of the valve is one of absolute precision.

A deviation of one-hundredth part of an inch would, if the valve were rigidly connected, either strain the gear or leave the valve open, neither condition being admissible.

It is clear, therefore, that the gear must control the opening of the valve, but the closing must be performed by weights, springs, or pressure.

In most drop valve engines the closing of the exhaust valves, although effected by springs, is controlled by the gear, and the valve cannot fall upon its seat more quickly than the exhaust mechanism will permit. A dashpot, therefore, is not required; but in the case of the steam valves where, at certain times, the connection between the valve and the driving gear is broken, a dashpot becomes an essential feature, otherwise the closing springs would force the valves on the seat violently, and the result would be disastrous. The proper action of the dashpot is of supreme importance in drop valve engines. It must ensure that the valve falls on its face freely but gently, and there must be no rebound.

Adjustment of springs and air valves should be provided. The dashpot springs should be long, with a short pitch of coil. In addition to the durability of a long spring there is a more uniform closing pressure obtained, and the governor effort to disengage the catches is practically constant throughout the stroke.

Short dashpot springs give excessive pressure on the catches as the valve rises to its top position. The length of spring should not be less than eight times the full lift of the valve.

The load on the springs when the valve is closed is 6 (outside diameter of large seat of valve) + steam preassure (area valve stem) − weight of valve, spindle and dashpot piston.

An adjustment giving 20 per cent variation on either side of this average load is provided by an adjusting screw on the spring, whilst the pressure in the air chamber may be regulated to control the fall of the valves. In the steam valves the current of steam assists the valves to seat, but, on the other

hand, the spindle gives an unbalanced upward pressure against the spring pressure.

In the exhaust valves the reverse conditions hold. When designing the releasing gear for high speeds it is well to have clearly in mind the sequence of events in a cycle, and the difficulties to be surmounted in performing these events in a short space of time.

Commencing at the point at which the outer end of the valve-lifting lever is in the top position, the first event is the striking of the catches as they engage. It is essential for quiet running that these should strike each other as slowly as possible, and it is clear that when the gear is driven by eccentrics the less the clearance and the smaller the eccentric throw the slower the striking velocity.

The valve is next lifted, and at a certain period the catches are released. The valve then descends, and the dashpot action takes place. If the descent is to be prompt the valve and the parts dropping with it must be as light as possible to avoid the delaying effect of inertia.

On the up-stroke of the eccentric the only event is the bringing of the catches into position for the next engagement.

Now if the clearance is to be made small in order to secure a low-striking velocity, there is little time left for the catches to slip into gear. The loose catch should therefore be as light as possible, so that inertia may not delay the operation.

(*To be continued.*)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 70.*)

It seems opportune here to mention a point with regard to the particular equations to be used in certain cases, which, though not really difficult of comprehension, has, nevertheless, been found to cause a certain amount of misunderstanding.

The trap point, or any other taper, may have any one of three forms: first, *the taper may be shorter than the overhang;* second, *the taper may be equal*

A B C

Plate Springs.—Fig. 20.

to the overhang; and third, *the taper may be longer than the overhang.* These three cases are shown in Fig. 20, where they are marked A, B, and C respectively.

For both the first and the second cases, when finding the X's for the "plate above," referring to the reaction from the "plate below," it must be noticed that the reaction from the plate below is applied to the untapered portion of the plate above, and so the equations for the square-end plates (22) to (24a) must be used: it is well to observe that Case B is the limit of Case A. For the third case, where the tapers overlap, the equations for the No. 2 point must be used, that is, equations (29) to (31a).

The Historical Plate Spring—The Basic Case of the Old Theory.

The historical case of plates of the same cross-section, with equal steps, and linear tapers (tapers in width) ending in points at the end of the step as shown in Fig. 12, comes under this section, and although a spring of this kind is only of academic interest, still, considering the fact that practically all of the commonly accepted formulæ refer only to this special case, and also bearing in mind that it is of historical importance, it seems desirable to consider it from the viewpoint of the new theory, and, at the same time, to show that the new theory is in perfect agreement with the old one (formulated by the leading mathematicians of their day) for this special case. The new theory does not attempt in any way to overthrow the old one—in fact, confirms it by showing its limitation—but the new theory shows that the old one is but a special case only, and one that never occurs in practice.

The new theory is so general in its scope as to cover actual practical conditions, and the relation of the new theory to the old one may be compared with that of Laurent's theorem to McLaurin's—the former is more general, and includes the latter.

In order to prove the statements regarding the equality of the reactions in the special case (Fig. 12) mentioned, a separate analysis appears to us to be the more direct way of proof. The fundamental condition is evidently that $\frac{M}{I}$ = constant, so that, for the tapered portion of the leaves:

$$\frac{EI_{n-1}}{W_{n-1}}\frac{d^2y}{dx^2} = l_{n-1} - l_n$$

Integrating this expression, and proceeding in the same manner as when obtaining equation (7), it will be found that the fundamental relation in this case is:

$$6E\delta_n = \frac{W_n(3l^3_n - 3l^2_n l_{n-1} + 3l_n l^2_{n-1} - l^3_{n-1}) + W_{n-1}(-3l_n l^2_{n-1} + l^3_{n-1})}{I_n}$$

$$= \frac{W_{n+1}(3l^2_n l_{n+1} - l^3_n) - 2W_n l^3_n}{I_{n+1}} \quad \ldots\ldots(32)$$

With plates of equal cross section ($I_{n+1} = I_n$) and equal steps ($l_n = nl_1$) the above equation reduces to:

$$W_n(4n^3 + 1) + W_{n-1}(-2n^3 + 3n^2 - 1) = W_{n+1}(2n^3 + 3n^2) \quad \ldots\ldots\ldots\ldots(33)$$

Putting n = 1 in this expression shows that $W_2 = W_1$: then putting $W_n = W_{n-1}$ shows that $W_{n+1} = W_n$, so it follows, from the inductive method of proof, that all of the W's are equal, and so as a consequence are all of the stresses.

For this special case, the deflection relation reduces to:

$$\delta_n = \frac{Wl^3_n}{2nEI} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(34)$$

which shows that the deflection of a laminated spring of this type is 50 per cent more than that of a plain plate with a moment of inertia equal to the sum of the moments of inertia of the plates forming the spring. This equation (34) is the ordinary formula of the academic texts.

There seems no further need to enlarge on this

point: it is introduced simply on account of its historical importance, and in order to show that the new theory includes the old one as a special case.

Further Investigation of Tapers.

We now pass on to the study of the other types of points:

No. 3 or Round Leaf Point.

It will readily be seen that the effect of this type of point on the stress and deflection relations of a spring is even less than that of the No. 2 point, and the same conclusions hold. All calculations for this type of point may be made by the equations given for the No. 1 point, with the assurance that they will be correct to at least four figures, which is ample for all practical purposes.

No. 4 or Circular Leaf Point.

The remarks made about the No. 3 point apply equally to this type. Exact calculations have been made for the No. 4 point, and they show that, for a leaf of which the length is double the width, the deflection at the end is almost exactly 1 in 1,000 more than for a similar square-end leaf; this amount, which is already negligible for practical considerations, decreases directly as the cube of the length increases, so that the effect of this type of taper on an actual spring leaf is absolutely negligible.

No. 5 or Parabolic Leaf Point.

This type of point is shown on a larger scale in Fig. 21, on which are also given the symbols which will be used in the analysis. The end of the leaf is of uniform thickness with the central portion, but it

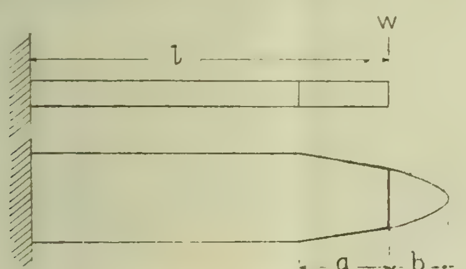


PLATE SPRINGS.—FIG. 21.

is cut to a parabolic form in the plane of the width. The effect of this taper is comparable with that of the No. 2 point, and is not usually of any importance.

In order to determine the deflections of leaves with the No. 5 point, we have:

First: From $x = o$ to $x = l - a$.

For this portion of the leaf the cross section is uniform, and equations (22) to (24a) for the No. 1 point apply directly.

Second: From $x = l - a$ to $x = l$.

For this portion of the leaf it is readily seen that the moment of inertia is:

$$I = I_0 \left(\frac{l + b - x}{a + b}\right)^{\frac{1}{2}}$$

and therefore:

$$\frac{EI_0}{W}\frac{d^2y}{dx^2} = \frac{(a+b)^{\frac{1}{2}}\,(l-x)}{(l+b-x)^{\frac{1}{2}}} \quad \ldots\ldots\ldots\ldots (35)$$

$$\frac{EI_0}{W}\frac{dy}{dx} = -(a+b)^{\frac{1}{2}}\left\{2b\,(l+b-x)^{\frac{1}{2}} - \frac{2}{3}\,(l+b-x)^{\frac{3}{2}}\right\} + C_1 \quad \ldots\ldots\ldots\ldots (36)$$

$$\frac{EI_0}{W}\,y = (a+b)^{\frac{1}{2}}\left\{-\frac{4}{3}b\,(l+b-x)^{\frac{3}{2}} + \frac{4}{15}\,(l+b-x)^{\frac{5}{2}}\right\} + C_1x + C_2 \quad \ldots\ldots\ldots\ldots (37)$$

where

$$C_1 = \frac{1}{2}\,(l-a)\,(l+a) + \frac{2}{3}(a+b)\,(a-2b) \quad \ldots (38)$$

$$C_2 = \frac{4}{15}\,(a+b)^2\,(4b-a) - \frac{1}{6}\,(l-a)^2\,(l+2a) - \frac{2}{3}\,(a+b)\,(a-2b)\,(l-a) \quad \ldots\ldots (39)$$

At the end of the leaf, where $x = l$, equations (36) and (37) reduce to:

$$\frac{EI_0}{W}\frac{dy}{dx} = \frac{4}{3}\,(a+b)^{\frac{1}{2}}b^{\frac{3}{2}} + C_1 \quad \ldots\ldots (36a)$$

$$\frac{EI_0}{W}\,y = -\frac{16}{15}\,(a+b)^{\frac{1}{2}}b^{\frac{5}{2}} + C_1l + C_2 \quad \ldots\ldots (37a)$$

When $b = o$ we have:

$$\frac{EI_0}{W}\,y = \frac{4}{15}\,a^{\frac{1}{2}}\,(l-x)^{\frac{5}{2}} + C_1x + C_2 \quad \ldots (37b)$$

$$C_1 = \frac{1}{2}\,l^2 + \frac{1}{6}a^2 \quad \ldots\ldots\ldots\ldots (38a)$$

$$C_2 = \frac{1}{15}a^3 - \frac{1}{6}l\,(l+a)\,(l-a) \quad \ldots\ldots (39a)$$

and when $b = o$ and $x = l$;

$$\frac{EI_0}{W}\,y = \frac{1}{3}\,l^3 + \frac{1}{15}\,a^3 \quad \ldots\ldots\ldots\ldots (37c)$$

As an example, if we apply equation (37c) to the bottom leaf of the spring of Fig. 17, making $a = 1.5$ in. (the length used for the spring of Fig. 19) and $b = o$, we find that $A_1 = .0007005$, as against .0006933 for the spring of Fig. 17 with the No. 1 point and .0007008 for the spring of Fig. 19 with the No. 2 point: in this case it is seen that the parabolic point makes even less difference than does the trap' point; in other cases the effect may be greater, but it is never of any commercial importance.

The result of the foregoing analysis of *the effects of tapering the points of the leaves of leaf springs in the plane of the width only* may be said to be that *such tapering has no practical effect on the strengths, reactions, stresses, or flexibilities of the springs*—in fact, aside from the æsthetic point of view, such tapering is of no practical use and it is a waste of money to perform the operations incidental to their manufacture. The special "point-trimming dies" are expensive to make and to keep in order, while the final result is simply that the springs "look" a little different from those with square pointed leaves.

We may here find the theoretical explanation of the observed practical fact that the heavy railroad and truck springs are usually made with square points, which are found to give just as good results in use as do those with sheared taper points.

With the advent of the reduction of cost of such modern appliances as the automobile came the demand, within the past three to four years, for reducing the costs of motor car springs.

As one of the costliest operations in spring manufacturing is the leaf-tapering operation, some spring manufacturers at first decided to do away with tapering altogether. We have seen this practised by at least one large automobile company—that is using a square end, Looks probably had much to do in discouraging the non-tapered springs, and, as a subsitute, and nearly equal in cost to the plain end, is the trapezoidal taper now found on many cars.

We have here an illustration in the use of "trap" points to make the eye believe that this is "as good" in results as the regular thickness tapering. The lack of analysis of these tapers has enabled the spring makers to dispose of an inferior product at a fair price, with the assumption that the product was first class.

It is not our wish to have the reader infer that the spring maker really knew that "trap" points were inferior to thickness tapers (indeed he cannot say what physical changes are produced by tapering) but we do wish to point out that springs of this kind are more economical to manufacture, and they have not the "life" of the thickness tapered variety. We believe that this is the first time and place in which the illusion has been dispelled, and the spring maker and spring user are herein given a clear answer to this question.*

(To be continued.)

BITUFERRI: THE ANTI-CORROSIVE FOR IRON AND STEEL.

By JAMES SCOTT.

Monetary Losses by Rusting.

If the monetary losses incurred by the rusting of iron and steel could be fully calculated, they would probably be found to run into hundreds of thousands of pounds sterling annually throughout the kingdom. Of the numerous attempts made to thwart its onset and progress, only a few can be said to be quite satisfactory from every point of view. One of the best processes, in cases where it can be applied, is that known as Bituferri, the manufacturers of which are Messrs. Archibald H. Hamilton and Co., Possilpark, Glasgow. Samples supplied to me by this firm for the purpose of testing its efficiency have proved remarkably good as a preservative for the metals named.

What Rusting Is.

Rusting has always been spoken of as a course of oxidation; which means essentially a combination of the oxygen of the air with the metal. But the factors which enter into the matter are far more complex than are covered by this simple term. Some investigators believe that carbon dioxide plays an important rôle in this connection; others have tried to prove that hydrogen peroxide is mainly responsible for it. The array of theories upon the subject, many based on exceptionally intricate and clever experiments, has been extraordinary; yet none of them, apart from the electrolytical one, which I will briefly describe, appear to fit all the necessary circumstances.

*The United States Government Liberty Truck Springs, Class B are excellent illustrations of the inefficient use of material due to lack of this knowledge concerning tapers on the part of those who have "designed" these members.

Solution Pressure.

Iron and steel are not uniform in minute structural detail, as many men who use them wrongly believe. That is to say, although we may have a piece of the metal, well polished, and presenting a level smooth surface of even colour and texture—apparently of the same nature in every part—it really consists of a multitude of minute particles of different composition. These are specifically named by metallurgists; but need not be stated on the present occasion. So far as we are now concerned, we have only to bear in mind the fact that these grains are capable of dissolving at different rates under the action of moist air, and so.

The definition, "Solution pressure," is adapted to denote this property, and a homely comparison may be made to properly convey its meaning. Suppose we press together a lot of sugar cubes, pieces of wax, fat, wood, scraps of vegetables, etc., so that they comprise a solid mass in sheet or

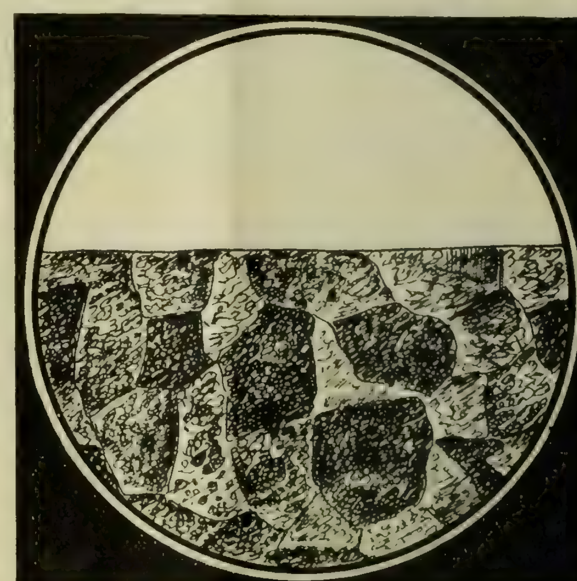


FIG. 1.—One twenty-fourth inch of iron plate, polished, showing its variegated grains, which encourage rusting (magnified).

block form. Upon exposing the whole to moist air the sugar would naturally be the first and easiest item to dissolve. The vegetable matter would gradually break down, and the wood would swell and exude; while the wax and fat would remain practically immune from attack unless heat accompanied the water, when they too would yield up some of themselves. Eventually, films consisting of a mixture of the dissolved ingredients would spread over all the whole mass. Imagine that this mass was reduced to such small dimensions that the nodules corresponded in size to the diversified grains in iron and steel, and the analogy (while, of course, having its potent limitations) will be sufficiently striking to enable anyone to understand the changes here recorded. The substances differ in solution pressure; which in plain language means the capacity for resistance to the solvent, compounding action of gases and fluids.

In iron (I need not keep on saying "and steel," for both are chemically the same) one kind of grain responds more rapidly to external agencies than do

the others, and the result is that the tiny cavities due to the changes which occur cause the development and adherence of films and powders of another character, altogether unlike those which previously existed. Some grains are electro-positive to the remainder, and others are electro-negative. Moisture serves as an electrolyte to enable minute electric currents to be set into force, the positively-charged grains engaging in opposition with those possessing a negative charge. Deposits of oxide or rust are then produced; and the process stops so far as those particular grains are concerned. Surrounding, and deeper companions are then affected. It is to prevent this electrolytical action that zinc plates are placed in boilers; but this side of the subject does not come within the range of my present consideration.

Pure Iron Does Not Rust.

In 1912, the scientist, Lambert, proved that absolutely pure iron—that is, consisting of nothing else but ferrite grains—did not rust, however long it was kept damp; and, on the other hand, impure iron (this means ordinary commercial metal) did not rust in pure water—that is, water containing no extra or free gases or other components. In the first case, as all parts dissolved at an equal rate, none of the grains could become anodic or cathodic, and thus no electric current could be commenced. In the second case, although the grains admitted of the generation of electricity, it was impossible to produce it owing to the absence of the required gases in the water.

It was found, however, that if the pure iron was pressed firmly in an agate mortar with an agate pestle (which could not give any foreign matter to the iron), the parts thus treated would rust while the rest remained clear and bright. It was, therefore, concluded that the pressed grains were altered in character so that they lost their homogeneity, and became resolved into a number of polarised objects.

A Curious Experiment.

A curious, easily performed experiment confirms

FIG. 2.—One twenty-fourth inch of iron plate covered with Bituferri, with the exception of a few tiny patches (magnified).

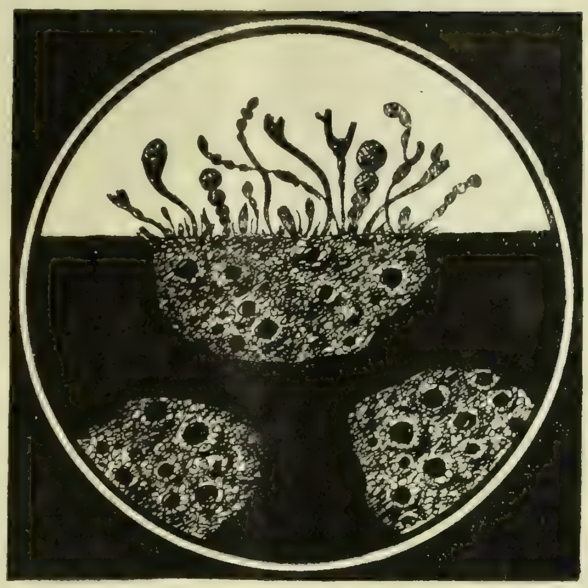


FIG. 3.—One twenty-fourth inch of the semi-protected iron plate after exposure to damp air. The naked patches have rusted (magnified).

these statements. If a piece of clean iron or steel (say a small penknife blade) is stood for a few moments in a solution of copper sulphate or nitrate, the actual metallic copper dissolved and concealed therein will be isolated upon the iron or steel in fir-like crystals. But when a piece of pure iron is thus disposed of, nothing of the kind happens, and the metal keeps in the same condition. In the former test the solution pressures of the grains vary; in the second they are alike, and do not permit any interchange of substance.

The term "impurities" hitherto referred to is only one of convenience, and signifies the graphite, carbide, sulphides, phosphides and so on, mixed together in the metal.

I will not go further into the theoretical problems, but turn to the selected preservative.

Bituferri.

From the industrial standpoint it is more valuable to secure something which will protect the metal against rust than to argue about its causes. The anti-corrosive named is a bituminous preparation, obtainable in either brown or black shades, which can be applied in a cold state; is elastic, and therefore does not crack, scale, nor chip off when hardened. It is non-conductive to heat and does not sweat, gives no imflammable vapours, and so is perfectly safe to use. Also, it is quite incapable of absorbing gases or fumes, and cannot pass any on to the iron.

The makers of this anti-corrosive have had laboratory tests of the following kind made with iron upon which it was painted. The covered metal was kept for long periods in water, and strong solutions of nitric acid, sulphuric acid, hydrochloric acid, ammonia hydrate, caustic soda, soda carbonate, and sea water without suffering from any defects whatever, the gloss of the substance being retained intact throughout the whole time of immersion, and afterwards when it was removed and dried. Surely this is enough antagonism to withstand. Less powerful agents could hardly be expected to have any influence if these cannot do so.

If an iron plate coated with the preservative, and allowed to completely dry, is scraped in odd places, and then immersed in, say, nitric acid, the latter will eat its way right through the cleared part of the metal, causing the apperance of holes, while the remainder does not suffer to the slightest extent. This is an extremely interesting and convincing demonstration, and proves the efficiency of the preparation.

In the illustrations are shown the results of my own observations. In Fig. 1 can be seen a common microscopical formation of a piece of iron, the grains being of different composition and density. I painted this metal with the preservative, after speckling it irregularly with little drops of wax, which were afterwards melted off, leaving those parts of the iron clear, as in Fig. 2.

This metal was then exposed for a few weeks to a very damp atmosphere, with the result that beads and filaments of oxide or rust too small for ordinary observation developed, as in Fig. 3. I have never seen any reference to these curious objects, apart from my own. The beading is due to droplets of condensed moisture retaining their shape during the formation of the rust, which they help to produce. The filaments I believe to be a sort of iron-laden fungus growth, an idea which it is difficult to establish, but is still being studied out by me. When these objects break off, they leave tiny pits behind.

By the way, rust occupies more space than the amount of metal affected by it, owing to its "growth." It seems to me that no better proofs of the utility of the preservative could be furnished than those now brought to the notice of the reader.

JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By Herbert C. Armitage, of Birmingham, Associate Member.

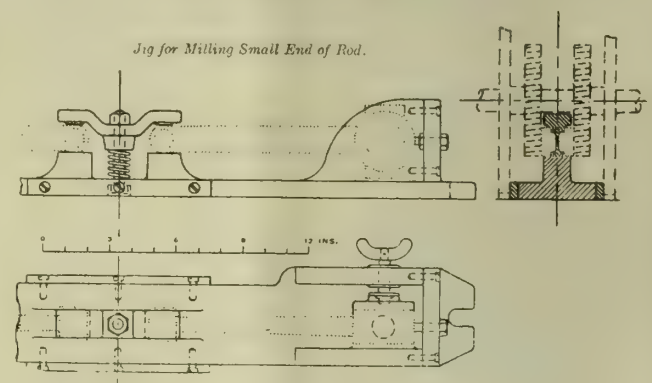
(Continued from page 66.)

Milling the Small End of Connecting-Rod (Fig. 6).

In all milling jigs it is one of the chief aims of the designer to make the height as small as possible, to prevent vibration and obtain stiffness. The rods are clamped at the large end against one of the machined faces and as longitudinal accuracy is not yet required, pegs are a sufficient support. The part where the cut has to be supported is clamped to a flat, or slightly dished plate, and tightening one bolt is sufficient to hold two rods without distortion. Note that the direction of the pressure from the cut must be downwards on to the solid plate, and not against the clamps.

Rough Drill Both Ends of Connecting-Rod (Fig. 7).

This jig is of "box" form, and as the walls of metal around the small hole are not to be machined outside, and also are comparatively small, the location is taken from a screwed bush, which seats conically upon the small end, thereby obtaining concentricity. The bosses of the connecting rod rest upon hardened bushes, the holes of which are larger than the drill-guide bushes, to clear the drills when breaking through the work. The bush under the large end has three relieved feet to keep the face clear of the chippings. The bushes are formed to make cups for the lubricant, and the whole base of the jig forms itself naturally into channels for carrying away the cutting solution. The bushes of the screw-down type are far from being ideal construction, as it is practically impossible to say that a threaded bush is perfectly

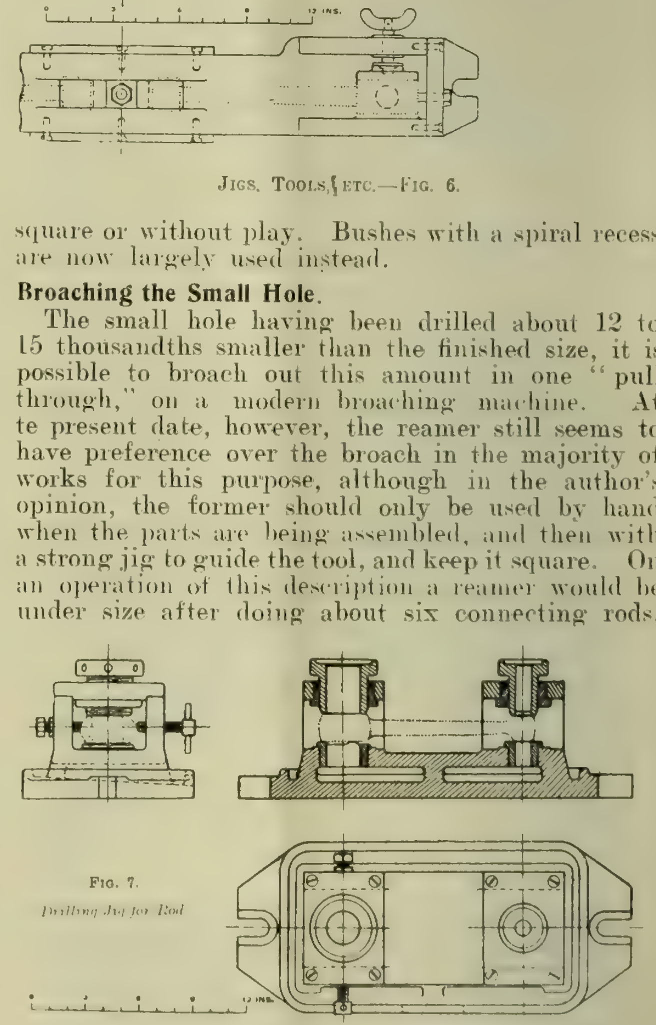


Jigs, Tools, etc.—Fig. 6.

square or without play. Bushes with a spiral recess are now largely used instead.

Broaching the Small Hole.

The small hole having been drilled about 12 to 15 thousandths smaller than the finished size, it is possible to broach out this amount in one "pull through," on a modern broaching machine. At te present date, however, the reamer still seems to have preference over the broach in the majority of works for this purpose, although in the author's opinion, the former should only be used by hand when the parts are being assembled, and then with a strong jig to guide the tool, and keep it square. On an operation of this description a reamer would be under size after doing about six connecting rods,



Jigs, Tools, etc.—Fig. 7.

whereas a broach can do from two to three hundred at the very least without being touched.

The reason why the broach is not universally used is chiefly due to the manufacturing difficulty. There is a considerable amount of work in cutting and sizing every separate tooth, and being long in proportion to its diameter, it invariably bends when being hardened. The usual practice is to use a case-hardening steel which can be "peaned" straight

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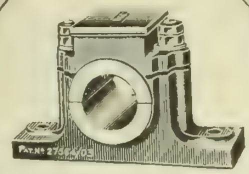

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Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 1 24	8 3 20	13 1 16	0 17 3 12	1 2 1 8	1 6 3 4	1 11 1 0	1 15 2 24	2 0 0 20	0
1	0 1 22	4 3 18	9 1 14	13 3 10	0 18 1 6	1 2 3 2	1 7 0 26	1 11 2 22	1 16 0 18	2 0 2 14	1
2	0 3 16	5 1 12	9 3 8	14 1 4	0 18 3 0	1 3 0 24	1 7 2 20	1 12 0 16	1 16 2 12	2 1 0 8	2
3	1 1 10	5 3 6	10 1 2	14 2 26	0 19 0 22	1 3 2 18	1 8 0 14	1 12 2 10	1 17 0 6	2 1 2 2	3
4	1 3 4	6 1 0	10 2 24	15 0 20	0 19 2 16	1 4 0 12	1 8 2 8	1 13 0 4	1 17 2 0	2 1 3 24	4
5	2 0 26	6 2 22	11 0 18	15 2 14	1 0 0 10	1 4 2 6	1 9 0 2	1 13 1 26	1 17 3 22	2 2 1 18	5
6	2 2 20	7 0 16	11 2 12	16 0 8	1 0 2 4	1 5 0 0	1 9 1 24	1 13 3 20	1 18 1 16	2 2 3 12	6
7	3 0 14	7 2 10	12 0 6	16 2 2	1 0 3 26	1 5 1 22	1 9 3 18	1 14 1 14	1 18 3 10	2 3 1 6	7
8	3 2 8	8 0 4	12 2 0	16 3 24	1 1 1 20	1 5 3 16	1 10 1 12	1 14 3 8	1 19 1 4	2 3 3 0	8
9	4 0 2	8 1 26	12 3 22	17 1 18	1 1 3 14	1 6 1 10	1 10 3 6	1 15 1 2	1 19 2 26	2 4 0 22	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	4·16	8·33	12·50	16·66	20·83	25·0	1 1·16	1 5·33	1 9·5	1 13·67	1 17·85	1·22	

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 50 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 4 2 16	4 9 1 4	6 13 3 20	8 18 2 8	11 3 0 24	13 7 3 12	15 12 2 0	17 17 0 16	20 1 3 4	0
10	0 4 1 24	2 9 0 12	4 13 3 0	6 18 1 16	9 3 0 4	11 7 2 20	13 12 1 8	15 16 3 24	18 1 2 12	20 6 1 0	10
20	0 8 3 20	2 13 2 8	4 18 0 24	7 2 3 12	9 7 2 0	11 12 0 16	13 16 3 4	16 1 1 20	18 6 0 8	20 10 2 24	20
30	0 13 1 16	2 18 0 4	5 2 2 20	7 7 1 8	9 11 3 24	11 16 2 12	14 1 1 0	16 5 3 16	18 10 2 4	20 15 0 20	30
40	0 17 3 12	3 2 2 0	5 7 0 16	7 11 3 4	9 16 1 20	12 1 0 8	14 5 2 24	16 10 1 12	18 15 0 0	20 19 2 16	40
50	1 2 1 8	3 6 3 24	5 11 2 12	7 16 1 0	10 0 3 16	12 5 2 4	14 10 0 20	16 14 3 8	18 19 1 24	21 4 0 12	50
60	1 6 3 4	3 11 1 20	5 16 0 8	8 0 2 24	10 5 1 12	12 10 0 0	14 14 2 16	16 19 1 4	19 3 3 20	21 8 2 8	60
70	1 11 1 0	3 15 3 16	6 0 2 4	8 5 0 20	10 9 3 8	12 14 1 24	14 19 0 12	17 3 3 0	19 8 1 16	21 13 0 4	70
80	1 15 2 24	4 0 1 12	6 5 0 0	8 9 2 16	10 14 1 4	12 18 3 20	15 3 2 8	17 8 0 24	19 12 3 12	21 17 2 0	80
90	2 0 0 20	4 4 3 8	6 9 1 24	8 14 0 12	10 18 3 0	13 3 1 16	15 8 0 4	17 12 2 20	19 17 1 8	22 1 3 24	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	22 6 1 20	44 12 3 12	66 19 1 4	89 5 2 24	111 12 0 16	133 18 2 8	156 5 0 0	178 11 1 20	200 17 3 12	223 4 1 4	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 49 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 1 14	8 3 0	13 0 14	0 17 2 0	1 1 3 14	1 6 1 0	1 10 2 14	1 15 0 0	1 19 1 14	0
1	0 1 21	4 3 7	9 0 21	13 2 7	0 17 3 21	1 2 1 7	1 6 2 21	1 11 0 7	1 15 1 21	1 19 3 7	1
2	0 3 14	5 1 0	9 2 14	14 0 0	0 18 1 14	1 2 3 0	1 7 0 14	1 11 2 0	1 15 3 14	2 0 1 0	2
3	1 1 7	5 2 21	10 0 7	14 1 21	0 18 3 7	1 3 0 21	1 7 2 7	1 11 3 21	1 16 1 7	2 0 2 21	3
4	1 3 0	6 0 14	10 2 0	14 3 14	0 19 1 0	1 3 2 14	1 8 0 0	1 12 1 14	1 16 3 0	2 1 0 14	4
5	2 0 21	6 2 7	10 3 21	15 1 7	0 19 2 21	1 4 0 7	1 8 1 21	1 12 3 7	1 17 0 21	2 1 2 7	5
6	2 2 14	7 0 0	11 1 14	15 3 0	1 0 0 14	1 4 2 0	1 8 3 14	1 13 1 0	1 17 2 14	2 2 0 0	6
7	3 0 7	7 1 21	11 3 7	16 0 21	1 0 2 7	1 4 3 21	1 9 1 7	1 13 2 21	1 18 0 7	2 2 1 21	7
8	3 2 0	7 3 14	12 1 0	16 2 14	1 1 0 0	1 5 1 14	1 9 3 0	1 14 0 14	1 18 2 0	2 2 3 14	8
9	3 3 21	8 1 7	12 2 21	17 0 7	1 1 1 21	1 5 3 7	1 10 0 21	1 14 2 27	1 18 3 21	2 3 1 7	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 4·08	0 8·16	0 12·25	0 16·33	0 20·41	0 24·50	1 0·58	1 4·66	1 8·76	1 12·83	1 16·91	1 21	

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 49 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 3 3 0	4 7 2 0	6 11 1 0	8 15 0 0	10 18 3 0	13 2 2 0	15 6 1 0	17 10 0 0	19 13 3 0	0
10	0 4 1 14	2 8 0 14	4 11 3 14	6 15 2 14	8 19 1 14	11 3 0 14	13 6 3 14	15 10 2 14	17 14 1 14	19 18 0 14	10
20	0 8 3 0	2 12 2 0	4 16 1 0	7 0 0 0	9 3 3 0	11 7 2 0	13 11 1 0	15 15 0 0	17 18 3 0	20 2 2 0	20
30	0 13 0 14	2 16 3 14	5 0 2 14	7 4 1 14	9 8 0 14	11 11 3 14	13 15 2 14	15 19 1 14	18 3 0 14	20 6 3 14	30
40	0 17 2 0	3 1 1 0	5 5 0 0	7 8 3 0	9 12 2 0	11 16 1 0	14 0 0 0	16 3 3 0	18 7 2 0	20 11 1 0	40
50	1 1 3 14	3 5 2 14	5 9 1 14	7 13 0 14	9 16 3 14	12 0 2 14	14 4 1 14	16 8 0 14	18 11 3 14	20 15 2 14	50
60	1 6 1 0	3 10 0 0	5 13 3 0	7 17 2 0	10 1 1 0	12 5 0 0	14 8 3 0	16 12 2 0	18 16 1 0	21 0 0 0	60
70	1 10 2 14	3 14 1 14	5 18 0 14	8 1 3 14	10 5 2 14	12 9 1 14	14 13 0 14	16 16 3 14	19 0 2 14	21 4 1 14	70
80	1 15 0 0	3 18 3 0	6 2 2 0	8 6 1 0	10 10 0 0	12 13 3 0	14 17 2 0	17 1 1 0	19 5 0 0	21 8 3 0	80
90	1 19 1 14	4 3 0 14	6 6 3 14	8 10 2 14	10 14 1 14	12 18 0 14	15 1 3 14	17 5 2 14	19 9 1 14	21 13 0 14	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	21 17 2 0	43 15 0 0	65 12 2 0	87 10 0 0	109 7 2 0	131 5 0 0	153 2 2 0	175 0 0 0	196 17 2 0	218 15 0 0	

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afterwards. This is one example of the general problems before the tool-making and manufacturing world to-day, and on which a few remarks will be offered later in the Paper.

Drill Bolt-Holes and Centre End of Connecting-Rod (Fig. 8).

The small hole having been finished to size by reaming or broaching, it is then used as the principal location for every subsequent operation. To drill the bolt holes, the connecting rod is placed upon two pegs which are fixed to a vertical plate. The jig illustrated is for use on a box-bed drilling machine, care being previously taken that the side of the bed is perfectly square. Attention must be drawn to the centre which is put into the top of the connecting rod during this operation. If this centre were not put in as a locating point for finishing operations, there would be no accurate location for the boring, since bolts have to be put in to secure the cap and thereby destroy the side holes as the natural spotting points.

Mill Sides of Rod.

This is a duplex jig, and similar to Fig. 9, and calls for little special comment, except that the peg which supports the large end has been cut away at the sides. As will be noticed in subsequent illustrations, this allows for slight errors of a few thousandths in the diameters, and centres of the holes.

Mill Across Bolt-Hole Bosses (Fig. 9).

In this jig it is possible to machine four rods at once. Two form cutters are used, and the importance of getting them in the correct position sideways will be noted. This is obtained by means of the three case-hardened spacing bushes ground accurately to make up the total width required. In setting up the cutters, lateral accuracy is obtained by the hardened steel guide working in the recess. The middle bush must have a considerable clearance to avoid the chippings which might rest on the top face of the strip.

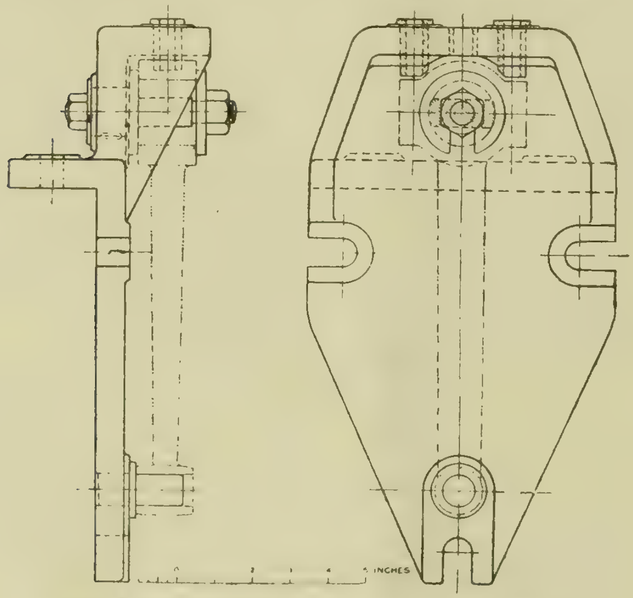


Fig. 8.—Jig for Drilling Bolt-holes in Connecting Rod.

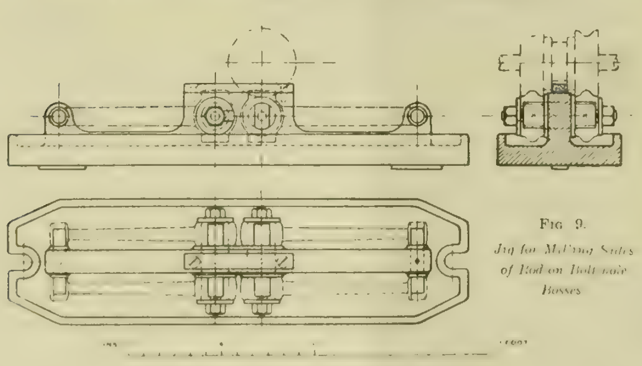


Fig. 9.
Jig for Milling Sides of Rod on Bolt-hole Bosses

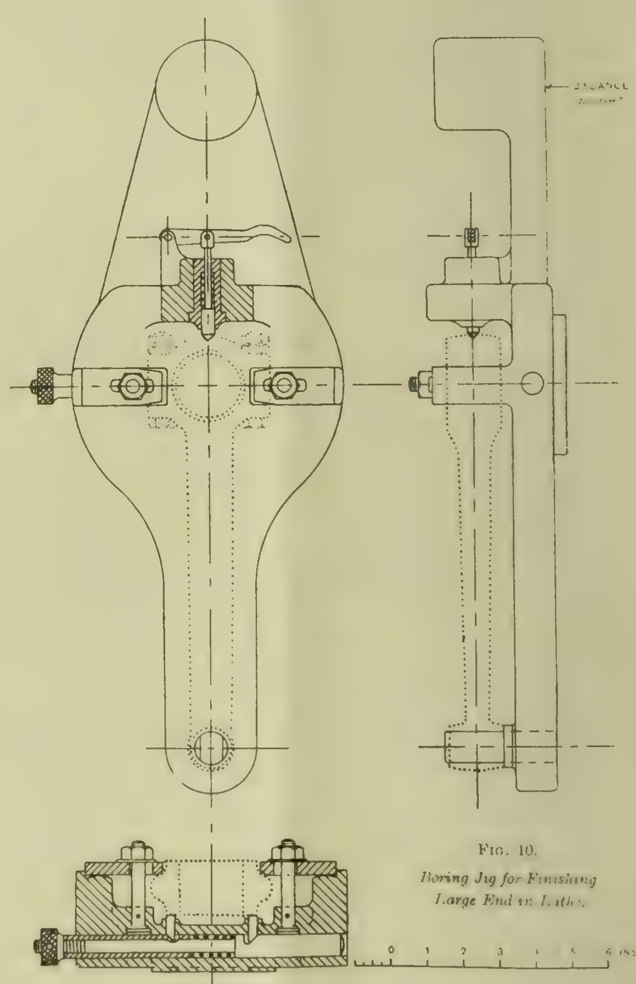


Fig. 10.
Boring Jig for Finishing Large End in Lathe.

Jigs, Tools, etc.

Milling Bolt-Faces.

It has not been considered necessary to show a drawing of this jig, as it will be practically the same in construction as Fig. 9, except that side facing cutters are used, and the cutters will operate at right angles to the direction in that case.

Parting off the Cap.

This is done in a jig, and the cap removed by means of a $^3/_{16}$ in. circular saw. The disc method of positioning the cutter laterally is again used, and location taken from the small hole.

Finish Bore the Large End (Fig. 10).

The cap having been bolted to the connecting rod

Table 4.

SCHEME FOR LARGE PRODUCTION.

Output = 20 per hour = 1,000 per week.

Operation No.	Description of Operation.	Fig. No. of Jig.	Time Required, Minutes per Piece.	Type of Machine.	No. of Machines.	Labour Cost per Piece.
1	Heat treatment of stamping	--	--		--	
2	File burrs, &c.					
3	Mill both ends of rod	11	20	Horizontal Miller.	7	3·3
4	Drill small end	12	3	Multiple Spindle Drill.	1	0·5
5	Drill large end		5	,, ,,	2	0·9
6	Broach small end		½	Broaching.	1	0·1
7	Drill bolt-holes and centre end of rod	13	5	Multiple Spindle Drill.	2	0·9
8	Mill sides of rod	-	15	Vertical Miller.	5	2·5
9	Mill across top bolt holes	- -	5	Horizontal Miller.	2	0·9
10	Mill sides of bolt faces	—	3	,, ,,	1	0·5
11	Part cap		5	,, ,,	2	0·9
12	Finish bore large end		20	Turret Lathe.	7	3·3
13	Run white metal in large end			—		—
14	Finish bore white metal in large end		10	Turret Lathe	3	1·7

after the sawing operation, the road is ready for finish boring. To do this (since the large hole is no longer round) the location is obtained from the centred hole. The boring jig shown is for use in a lathe, and the spigot fits in a recess in the face plate. The equalising clamp is a construction detail worthy of notice, as it is placed here to make a support against the pressure of the cutting tools. If no stops are used, there is danger of twisting the connecting rod, and throwing the finished hole out of alignment with the small hole; and accuracy in this respect is most essential. When the rod is machined in a centre lathe, the work will require turning round and resetting. The rod is then white-metalled, and afterwards only requires a finish boring operation on the soft metal. The boring jig is practically identical with the one already illustrated in Fig. 10.

Scheme for Large Production.

The jigs which are now to be described have for their object the production of an average of 20 rods per hour, and will represent in their construction the nearest it is possible to get to continuous cutting without the aid of special machines, and using standard machine tools. The layout is shown in Table 4, and scarcely differs in the order of operations from the first one.

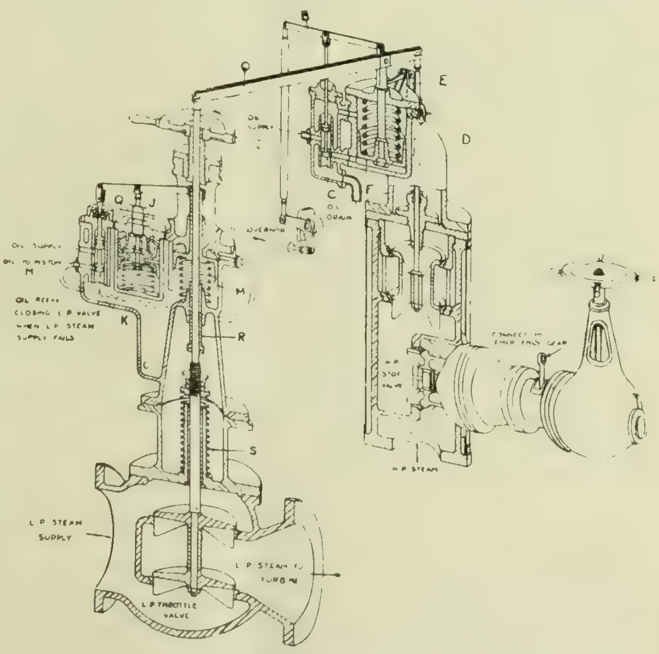
(To be continued.)

MODERN STEAM TURBINES.

By J. Humphrey.

(Continued from page 54.)

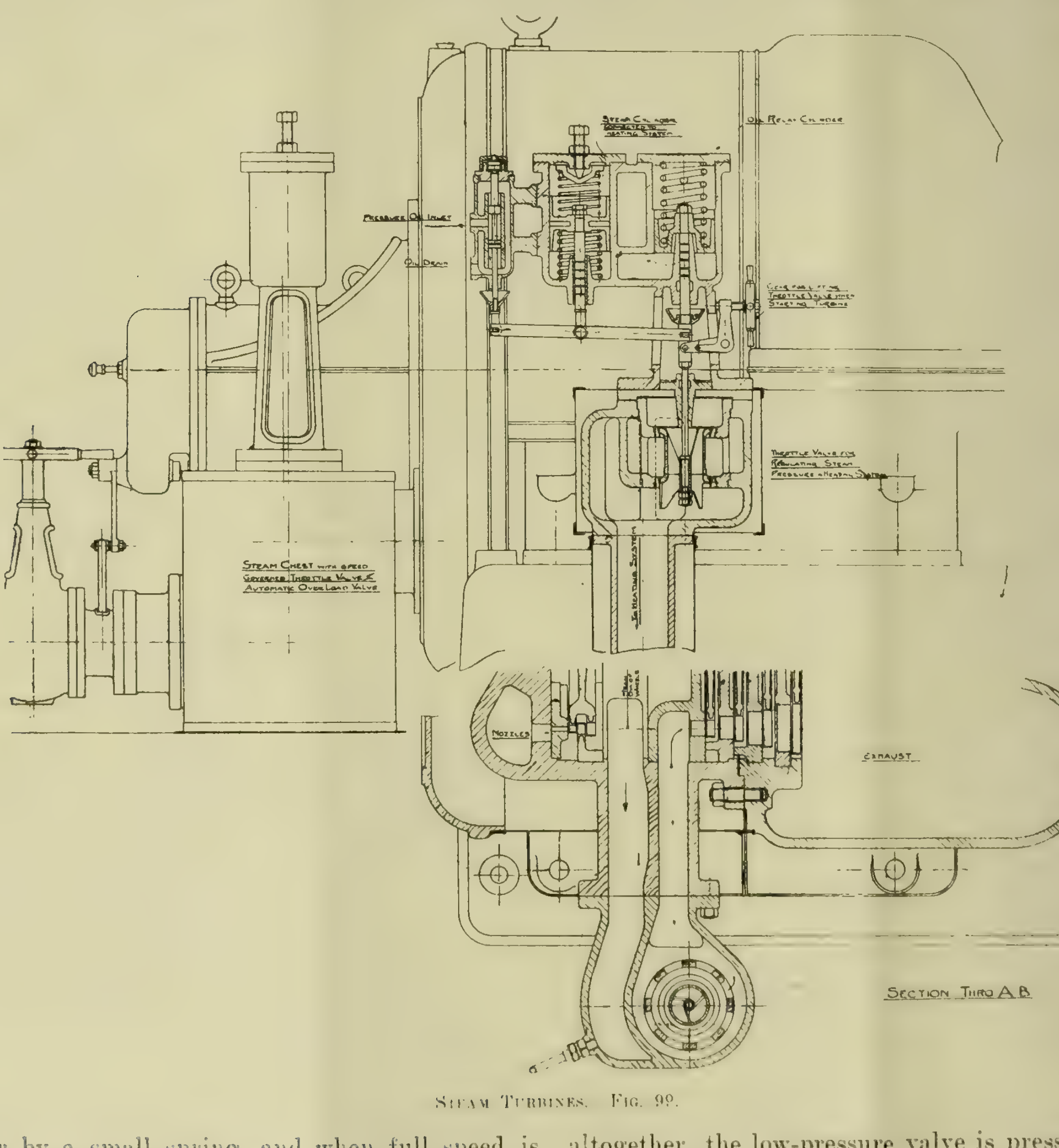
In common with most other turbine builders, Messrs. Fraser and Chalmers build low-pressure, mixed-pressure, back-pressure, and reducing turbines; also small turbines suitable for driving pumps, blowers, etc. The uses to which turbines other than ordinary high-pressure turbines can be put have already been adequately considered in this series of articles, but attention may be called to one or two special constructional details of the Fraser and Chalmers machines. Fig. 98 shows the governor gear of this firm's mixed-pressure turbine. The high-pressure



Steam Turbines Fig. 98.

inlet is shown on the right, and the low-pressure inlet on the left, and the gear is shown in the position ready for starting the turbine on either high-pressure or low-pressure steam. First, the high and low-pressure valves must be opened, when, by means of the starting lever E, the piston of the main valve F is lifted, and low-pressure steam is admitted to

the turbine. But if no low-pressure steam is available the low-pressure valve would be kept closed by the piston M, and the high-pressure valve woud be opened instead. By opening one or the other of these two valves by the starting lever E the turbine is started and the oil pump delivers oil under pressure to the oil relay G and under the piston F, which is lifted higher with the result that more steam is gradually admitted to the turbine until it attains full speed. As soon as the force of the spring D is overcome by the oil pressure, the lever E is forced out consequence, the spring Q forces the piston J down and the operating plunger K admits oil to the top of the piston M, which is forced down and so closes the low-pressure valve to such an extent that the pressure in the low-pressure supply inlet attains its normal value. Whilst the low-pressure valve is being closed the high-pressure valve opens, thus admitting the requisite quantity of high-pressure steam, which, together with the available low-pressure steam, enables the turbine to cope with its load. If the low-pressure steam supply fails



Steam Turbines. Fig. 99.

of gear by a small spring, and when full speed is reached the controlling or speed governor comes into operation, and through the medium of the lever B controls the relay plunger G, admittting or relieving oil pressure under the piston F as the load varies, the spring D always tending to close the valves. Under normal conditions and when running on low-pressure steam, the high-pressure valve is kept closed by the spring S working on the pivoted lever O, so that the piston F operates the low-pressure valve only. But in the event of the low-pressure steam supply becoming inadequate, and the pressure falling in altogether, the low-pressure valve is pressed against its seat by the oil-pressure acting on the top of the piston M when the turbine works with high-pressure steam. Only when the supply of low-pressure steam is insufficient for dealing with the load does the turbine take high-pressure steam, the change over from high-pressure to low-pressure steam or *vice versa* being entirely independent of the operation of the ordinary controlling governor. The emergency governor fitted to these mixed-pressure turbines not only closes the main valve but also opens a vacuum breaking valve and relieves at the same time the oil

pressure under the piston F when the spring D presses the high and low-pressure valves down on to their seats.

Details of the valve gear fitted to the Fraser and Chalmers reducing turbines are shown in Fig. 99. This class of turbine, it will be remembered, is suitable for use when it is desired to obtain a supply of low-pressure steam for heating, and when the demand for such steam is an intermittent one. In the reducing turbine the high-pressure steam is admitted to the high-pressure portion of the turbine, where it expands to the pressure required in the heating system, the chamber after the high-pressure portion being connected, as shown in Fig. 98, to the heating system as well as the low-pressure part of the turbine. In the connection to the low-pressure part of the turbine, a regulating valve is inserted, and this valve is operated by the pressure in the heating system, through the medium of an oil relay. If the heating system is shut off, the pressure in the heating piping will naturally rise, with the result that the regulating valve in front of the low-pressure part of the turbine is opened wider, thereby passing more steam through the low-pressure part of the turbine and into the condenser. If, on the other hand, more steam is required in the heating system, the pressure therein slightly falls, and the regulating valve closes so as to reduce the amount of steam passing into the condenser. When the heating system is shut off, the turbine operates in exactly the same manner as an ordinary high-pressure turbine. On the other hand, if all steam taken by the turbine is used for heating, the machine then operates as an ordinary back-pressure turbine, the low-pressure stages running in vacuum.

(To be continued.)

A NATIONAL POLICY OF COAL CONSERVATION.*

Although coal is the world's most important fuel, and the principal source of its artificial heat, light, and power, it is far too valuable a material to be burnt indiscriminately by people ignorant of its true worth, as in the bad old days that are behind us. When suitably handled by the chemist, it is capable of yielding by-products—such, for instance, as naphthenes, benzols, tars, ammonia, etc.—whose values as raw materials for the manufacture of synthetic drugs and dyes far exceed their mere heat-producing powers when burnt in the ordinary way in our furnaces and fireplaces. Hence the chemists' objection to the burning of raw coal before it has been treated for the extraction of such by-products. My object in this lecture is to discuss what ought to be our national policy in regard to the utilisation of coal to the best advantage of the community as a whole. Such a policy will not concern itself so much with prolonging the life of our coal-fields as with getting the utmost "economic result" out of the coal we actually use. And by "economic result" I mean the maximum return in value for a given expenditure of capital and labour on the raw material operated upon.

* Lecture delivered before the Royal Society of Arts by William Arthur Bone, D.Sc., Ph.D., F.R.S., professor of Chemical Technology at the Imperial College of Science and Technology, London.

If you will think over that definition you will see that I do not use the term "thermal efficiency." The thermal or power result is one of the many returns that can be got out of coal; but there are other considerations which enter into the problem besides that of thermal efficiency. In discussing this question, we want to get out of the way of talking only about thermal efficiency. It is a very important—in some cases the predominant—factor, but it is not always the deciding one. For instance, I have sometimes had to consider schemes for the production of power from coal or waste gases that have been thermally more, but commercially less, efficient than alternative schemes that have ultimately been selected: in such cases the final ground of decision has not been thermal efficiency, but the total result. This is not always sufficiently understood by so-called scientific people—in fact, commercial people often take a more scientific view of these questions than does the scientific man, because they look at more factors than he does. Therefore, I want you to understand that the term "economic result" means the maximum return, for a given expenditure of capital and labour, from the raw material operated upon.

Inasmuch as immense quantities of coal must necessarily be consumed every day to maintain our social and industrial system, and also as the purposes for which they are consumed are various—such as, for instance, to generate power, to smelt iron, to make steel and other special alloys, to produce public supplies of gas, to warm our houses, and to cook our food—it behoves the nation to ensure that its available reserves of coal are used in ways that are calculated to fulfil such purposes to the best advantage, and that no individual or section of the community is allowed to use them wastefully. Now, paradoxical though it may seem, past experience has abundantly proved the truth of Jevons's dictum, that the more economy is practised in the use of coal, the more will its consumption increase, because, as he rightly said: "Economy multiplies the value and efficiency of our chief material; it indefinitely increases our wealth and means of subsistence; and it leads to an extension of our population, work, and commerce, which is gratifying in the present, but must lead to an earlier end." Hence it follows that we must not expect to prolong the duration of our national coal reserves by using them more scientifically; we shall probably only hasten the end by so doing. The true object of national fuel economy should be to ensure that our coal is used to the best and the fullest advantage by every class of customer. For true economy lies not so much in using sparingly as in using well.

Before considering the application of this principle to our subject, I will direct your attention to the following estimate of our national consumption of coal in the year 1913:—

THE PRINCIPAL USES OF COAL IN THE UNITED KINGDOM IN 1913.

	Million tons.
1. Mines and factories	80
2. Iron and steel and metallurgical industries	32
3. Manufacture of bricks, ceramics, glass, and chemicals	6
4. Railways and coasting steamers	17
5. Gasworks	19
6. Domestic purposes	35
Total	189

	Per cent approx.
Power	40
Iron and steel works } Carbonisation }	27
Domestic	20
Transport	10

It is difficult to state exactly what is our coal consumption in a given year for each of the above purposes; but it may be said with a tolerable degree of accuracy that, before the war, the coal annually consumed in our mines and factories, chiefly for power purposes, amounted to about 80 million tons; in the iron and steel and other metallurgical industries, to about 32 million tons; for the manufacture of bricks, ceramics, glass, and chemicals, to about 6 million tons; for railways and coasting steamers, to about 17 million tons; in gasworks, to about 19 million tons; and for domestic purposes, to about 35 million tons a year. Or, in the words, for the purpose of power we consumed about 40 per cent of the total coal used in the Kingdom: in connection with iron and steel works and carbonisation (including gas-works and coke-ovens, which I bracket with iron and steel for a reason which will become apparent later), we used about 27 per cent; for domestic purposes, about 20 per cent; and for transport (including railways and coasting steamers), about 10 per cent—leaving only a small percentage for other purposes. If we take power, metallurgical and carbonisation (which are closely allied), and domestic uses, we shall have accounted for nearly 87 per cent of the whole of the coal consumption of the Kingdom. Upon these three classes of uses, I propose to concentrate in the remainder of these lectures.

Classification and uses of Coals.

Before proceeding further, however, I would remind you that, when we use the word "coal," we are employing a term which is very comprehensive. It is really a generic term, comprising a great many different groups of raw materials—all of which have the same kind of origin, but each possessing its individual special qualities, as shown in table below.

Of these four great groups of coals, each of which (and specially I., II., and III.) may be sub-divided into a number of classes, the the Sub-Bituminous (lignites and brown coals of Tertiary origin), have hitherto not attained to any great economic importance, because they are relatively low-grade, with high moisture (up to 50 per cent) content, which has hitherto precluded their transportation over long distances. They are not found, to any large extent, in Great Britain, but occur plentifully in the Central European Plain (Germany and Austria), over large areas in the United States (Texas, Arkansas, and Louisiana; North Dakota, Montana, and Wyoming), in Canada (Alberta and Saskatchewan). Immense deposits of them (upwards of 300 ft. thick) occur in the province of Victoria (Australia), and there are also important ones in the Federated Malay States. The problem of how best to utilise lignites and brown coals is rapidly assuming first-rate importance, and for the Empire as a whole it is one of great and pressing moment. The famous Morwell brown coal of Victoria, one of the most

Classification of Coals.

	I.	II.	III.	IV.
Genus or Group.	Sub-Bituminous, including Brown Coal and Lignites.	Bituminous.	Semi-Bituminous and Anthracitic.	Anthracites.
Geological Period.	Chiefly Tertiary.	Mesozoic Permo-carboniferous and Carboniferous.	Chiefly Carboniferous (? Some Permocarboniferous).	
Percentage "Volatiles" Yielded at 900° C.	Above 45.	Between 18 and 40.	Between 8 and 20.	Below 8.
Character of Carbonised Residue.	Non-Coherent.	A coherent "coke."	Non-coherent.	
Principal Uses.	(i.) Distillation with Briquetting of Residue. (ii.) Steam-raising.	(i.) Coking. (ii.) Gas-making. (iii.) Steam-raising. (iv.) Furnace purposes.	Smokeless steam coals. Admiralty Class.	Domestic Heating in Closed Stoves. Malting Kilns, &c.
Remarks as to By Products. Recovery on Distillation.	Often economical.	Always economical.	Rarely economical.	Never economical.

wonderful stores of potential energy in the whole world, is being investigated by a Victorian Government Commission with a view to its utilisation on a big scale for the generation of electric power both for the Government railways and for the city of Melbourne. The Canadian Government has recently established a Lignite Utilisation Board, which is investigating the lignite of Alberta and Saskatchewan. The Americans are also busy with the problem.

(To be continued.)

A METHOD OF CHECKING THE ALIGNMENT OF DIESEL ENGINE SHAFTS, AND A MEANS OF PROVING IF A SHAFT IS ACTUALLY BEDDING IN ITS BEARINGS.

(Concluded from page 67.)

Mr. P. H. Smith (*communicated*).—The system described is useful for the purpose referred to in the title, but its application to actual realignment of crank-shaft bearings is not simple, as lack of alignment between journals and bearings is generally a complex phenomenon and the system expounded by Mr. Windeler sometimes fails to help one.

Adverting to my paper, "Precautionary measures to adopt to prolong the life of Diesel engine crankshafts," read before the Association on 12th July, 1916, I referred to a method of ensuring subsequent proper alignment of main bearings by measuring the thickness of the shells interposed between the journal and bedplate housing. A comprehensive experience of this system applied to many scores of engines during the past three years has proved the system to be valuable, for of shafts realigned by us, or under our supervision, none has failed. Of shafts reputed to have been rebedded on this system, but not by us or under our supervision, one only has been reported to have failed, and the system in this case has been exonerated from all blame by the user of the engine.

But in these three years, the system has been shown to have its limitations, and these concern mainly the personal equation. As indicated in my paper above referred to, journals may be, and generally are, out of centre to one another. This may amount to from $1\frac{1}{2}$ to 2/1000-in. in the A and B bearings (adjoining the vertical shaft), or 2 to 3/1000-in. between the others, and the shaft will run satisfactorily with apparent safety, if the erector is circumspect in bedding the bearings.

The above-mentioned inaccuracies of concentricity are quite usual in all industrial engines, and are tolerable. A shaft bedded purely on the old method of equalising the amount of marking shown on the main bearings will have its main bearings low at the eccentric journals, to somewhere about the extent of twice the eccentricity.

Eccentricity of journals has to be allowed for. One method of discovering it is to examine the marking paint (whatever it may be) on the journals, but a better method is to gauge how much weight is taken by each bearing at top and bottom centres and on the quarters, and when a journal is known to be eccentric I prefer to leave its bearing on the high side and to be prepared to take it out for a further scraping should it run unduly warm on the trial run. This eccentricity of journals is one of the difficulties militating against the simple application of the method of gauging between crank-webs for the establishment of alignment.

Other inherent defects of machining also present themselves for consideration. These are lack of roundness of journals and that the axis of one journal may be inclined to the axes of adjacent journals. These faults are negligible in most cases, and really only become serious in the case of replace shafts ordered by the user direct and not through the engine manufacturer, who safeguards himself and his customer by having the shaft made to rigid specification.

But lack of concentricity of journals must not be neglected. It is an important factor even in the best made engines.

Gauging between the webs at the top and bottom centres may or may not reveal whether the shaft is lying truly in its bearings.

An example of interest occurs to mind where a four-throw shaft was bedded in the usual way, namely, with the engine stripped. The shaft was passed, and the thickness of the bearing shells recorded. The webs were gauged on top and bottom centres and the difference was slight. When, however, the flywheel was erected there was a considerable difference in the web gauging of the second line, on top and bottom centres.

Bearings do not usually wear equally throughout their length. One end often wears down several thousandths of an inch more than the other. Actual calibrations of the wear of a 4-throw shaft are represented diagrammatically in Fig. 1. This shaft had run about 8,000 hours. If the webs are gauged without weight on the shaft, very much less difference in the spacing on top and bottom centres will be recorded than what occurs under working conditions. This at least applies to the Diesel engine shaft, but may not to the less rigid steam engine shaft.

In about 80 per cent of the cases I have investigated, the B bearing is generally 3 to 7/1000 in. lower at the web side than the helical wheel side (see Fig. 2), when the shaft requires realignment.

Consequently the shaft, of its own weight, touches only on the helical wheel side and by gauging between the webs on top and bottom dead centres one will not obtain a fair indication of the amount of wear actually existing. In fact, one often gets no indication whatever by gauging between the webs that the B bearing is in a very unsatisfactory state.

Another point. Supposing one obtains appreciable difference in gauging between the webs on top and bottom centres, how are the readings to be usefully interpreted to restore realignment? If there is a difference between top and bottom centres, then the fault may be either to the right or left of the webs. If the line calibrated be in the centre of a multi-throw crank the obvious method of procedure is to calibrate adjacent webs, and so establish the high and low bearings (or eccentric journals) connected to the centre web. But, with an extended experience, I have come to the conclusion that this method is liable to be too misleading, and have arrived at the conclusion that whichever system (there are but two) is adopted, we ultimately have to rely upon the skilled erector, aided by the indications of the

scientific system for what it is worth, even as we rely on the man and not the indicator to effect Diesel engine combustion adjustments.

Finally, and having given reasons why I do not favour relying on gauging between the webs as a criterion for crank-shaft bearing alignment, or the lack of it, I would mention that I give this system an easy first place as a method of setting the bearing carrying the extension shaft. Hitherto this has been extraordinarily difficult to ensure, and a system of having a guess and packing up the outboard bearing "high enough" has undoubtedly been the most fruitful source of broken crank-shafts. Even so, I rely on the method only after having taken up the running clearance by pulling down the bearing caps on to the shaft with a piece of millboard (Bristol board is the best) interposed between the top bearings and their journals.

Having given up the system for most purposes in Diesel engines, I am now investigating its utility for 4-throw vertical tandem gas engine shafts, and hope to have a complete collection of data by the middle of September. As the gas engine shaft is not quite so stiff as a Diesel shaft, the system of gauging between the webs to ascertain lack of alignment may possibly be of greater use in gas engines than I have found it in Diesels.

Mr. H. S. Whiteley (*communicated*).—Arising out of Mr. G. E. Windeler's paper *re* alignment of crank-shaft, I thought perhaps the following particulars taken from my crank-shaft might be of interest, as the measurements of the various bearings are so abnormal.

The crank-shaft belongs to a 2-cylinder Burmeister and Wain engine, and has been running practically day and night since it was first installed in 1911 till the end of 1917.

Owing to the increased end play on the shaft, together with the irregularity of the flywheel, I decided to strip the engine down for examination and rebedding of the crank-shaft. The measurements shown upon the schedule herewith were taken upon the same lines as Mr. Windeler indicates in his paper, and show also the extreme variation for each position of each bearing, before and after removal of the flywheel.

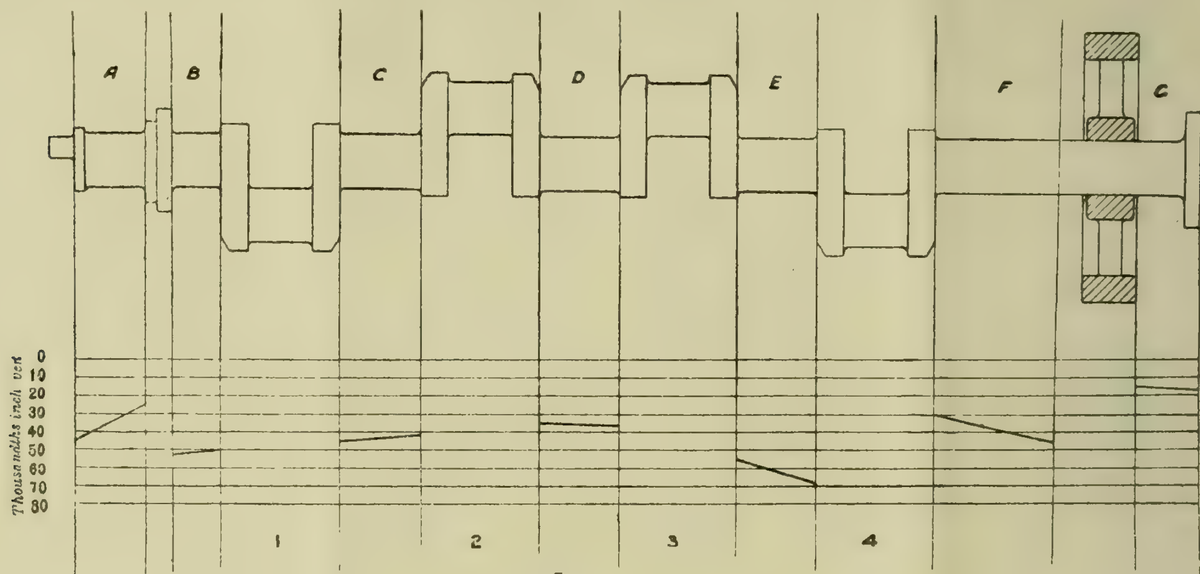


FIG. 1

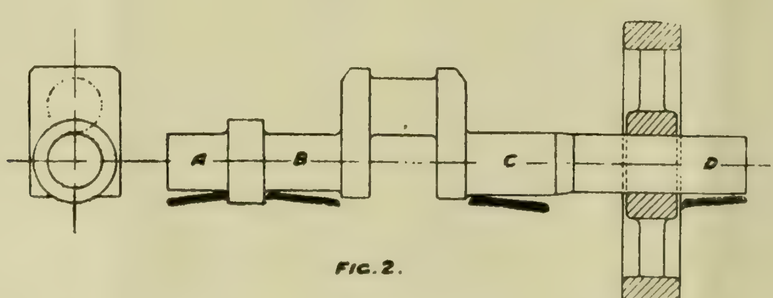


FIG. 2.

Figs. 1 and 2 (accompanying Mr. P. H. Smith's communication).

The shaft was afterwards lifted out, placed between lathe centres, trued up by the end bearings, and the centre bearing is out of truth by .125 of an inch.

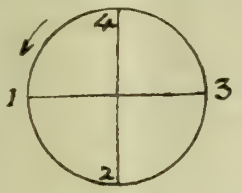
The shaft itself does not appear unduly worn, it is only slightly oval and has a very fine surface.

The webs of B crank—*i.e.*, the one nearest the flywheel—were 8/1000 of an inch open, this measurement being taken after the shaft was lifted out of its bearings.

I think it speaks well for this shaft that it has not fractured long before this. I am advised it is not possible to straighten this shaft to enable it to be again used, the risk of fracture being too great, consequently I am putting in a new one.

30th April, 1919.

Readings taken from Top of Bedplate to Top of Crank-shaft at Four Positions of Crank with Flywheel in Position.



	No. 1 Bearing.	No. 2 Bearing.	No. 3 Bearing.	No. 4 Bearing.
1st position	4/1000	20/1000	46/1000	48/1000
2nd position	16/1000	28/1000	46/1000	50/1000
3rd position	37/1000	44/1000	40/1000	50/1000
4th position	37/1000	44/1000	40/1000	50/1000
Maximum difference of each bearing during one revolution	33/1000	24/1000	6/1000	2/1000

Readings taken after removal of Flywheel.

	No. 1 Bearing.	No. 2 Bearing.	No. 3 Bearing.	No. 4 Bearing.
1st position	12/1000	25/1000	50/1000	41/1000
2nd position	21/1000	26/1000	48/1000	40/1000
3rd position	42/1000	36/1000	15/1000	23/1000
4th position	39/1000	37/1000	24/1000	27/1000
Maximum difference of each bearing during one revolution	30/1000	12/1000	35/1000	11/1000

Difference in heights of bearings:—

No. 1 —$\frac{6}{1000}$— No. 2 $\frac{8}{1000}$ No. 3 —$\frac{12}{1000}$— No. 4 $\frac{15}{1000}$

$\therefore \frac{9}{1000}$ low at flywheel end.

Mr. G. E. Windeler's Reply.

Mr. Windeler thanked Mr. Dykes for his kind remarks. Experience had proved beyond doubt that the employment of this method of checking crank-shafts for want of alignment and support would remove, or at least reduce, very considerably the risks of crank-shafts fracturing through distortion under working loads. It was not intended to supersede periodical dismantling of the bearings, but rather to indicate by a simple and easily used method and device when they actually did require detailed and individual inspection and attention.

He fully agreed with Mr. Holliday that it was very important to remove any chances of a crank-shaft being out of line and unsupported by any of its bearings. He noted with interest that his firm had used the method of measuring between the crank-webs chiefly for purposes of alignment of outerboard bearings. It was certainly a very useful and thoroughly reliable method for the alignment of such bearings, and for ensuring that the bearings on either side of the flywheel and dynamo were taking their correct share of supporting the shaft.

Mr. Squire's question was a very important one. Mr. Windeler said he could not give the information in the form desired, but at some later date would no doubt be able to publish data bearing on the subject. He agreed that if some safe means of artificially loading the piston could be employed, the exact amount of deflection and want of support of the shaft could be obtained. The use of the blast-air pressure would serve the purpose, but it might prove very unsafe, remembering that the man who was carrying out the measurements would be exposed to some risk if the method suggested was used carelessly.

The figures given by Mr. Squire appeared to indicate that the outer bearing was slightly low, causing No. 3 crank-webs to close in on top centre. No. 2 webs also showed some distortion on the "negative" side, and indicated that bearings C and D were high. This is proved by No. 1 crank-webs being distorted on the "positive" side.

The end play of 18/1000 in. indicated that the shaft bearings were not truly in alignment.

Mr. Windeler has also replied as follows to the communications received from Mr. P. H. Smith and Mr. H. S. Whiteley:—

Knowing of Mr. Smith's extended and enthusiastic work on Diesel engines, I have read his views with considerable interest and thoughtfulness. I have also devoted much time and thought to the important problem of alignment of engine parts, and in particular to that of aligning of crank-shafts, and, notwithstanding Mr. Smith's views, I still hold that measuring between the crank-webs is a simple and effective method of finding out whether a shaft is being properly supported in its bearings, especially as the preliminary investigation can be carried out without removing any of the engine parts. It is also a very useful adjunct to bedding a crank-shaft into its bearings. The question of eccentricity of journals, errors of roundness and inclination of axes of journals one to another must be dealt with and eliminated by the engine builder during the process of manufacture. If these errors were not removed, overheating, increased wear and uneven wear would take place in the bearings and produce results indicated by Mr. Smith. The fact that the method has proved so valuable as a check to the alignment of outer bearings rather tends to prove that it can be usefully and reliably employed in other directions. I quite agree with Mr. Smith that the shaft should

be "nipped" down when checking the outer bearing for alignment.

Mr. Whiteley's communication is very important, and enhances the value of the point pressed by me that end movement on a Diesel engine crank-shaft is the first indication that the shaft is not being properly supported or that its bearings are out of alignment. The figures and results obtained by Mr. Whiteley speak for themselves. The material used in the shaft is certainly of high ductility, and it would, I am sure, be of considerable interest to the members of the Association if Mr. Whiteley could have some test pieces cut out of the shaft at different points, and physical and micrographic records taken of the material.

The discussion has proved both instructive and interesting, and I thank the Association for having given me the opportunity of having this most important matter so thoroughly discussed.

(Concluded.)

DIESEL ENGINE USERS' ASSOCIATION.

At the meeting of the Diesel Engine Users' Association, on 20th November, the honorary secretary reported the progress that had been made in forming the Provisional Committee for the proposed Research Association for Liquid Fuels, under the Government scheme of industrial research.

There was a discussion on the subject of connecting rod bolts which had been considered at the previous meeting.

Mr. Geo. W. F. Horner referred to the greater torsional effect due to twisting, when tightening up the smaller size of bolts. This accounted for the lower stress value specified by the insurance companies in the case of small bolts. Taking all circumstances into account he was not in favour of periodic heat treatment of connecting rod bolts.

Mr. H. Squire gave particulars of tests carried out on connecting rod bolts of a Diesel engine, after having been in use for 23,500 hours, corresponding to 214,000,000 revolutions of the engine. Tests of ultimate tensile strength, elastic limit, elongation, reduction in area, and hardness carried out before annealing, and then after annealing at 900 deg. Cen. showed that the annealing process had practically no effect on the material. The bolts, which were $1\frac{13}{16}$ in. at the smallest diameter, were apparently of wrought iron, and were the original bolts supplied with the engine in 1913.

Mr. A. W. A. Chivers, while not deprecating the general effect of annealing or heat treatment, did not consider periodic heat treatment necessary or desirable in the case of connecting rod bolts.

Mr. A. J. Wilson made an interesting communication, in which he referred to the experience obtained in the use of connecting-rod bolts of 31 35 ton steel on submarine type Diesel engines, and subsequently 3 per cent nickel steel when the speed of the engines was increased.

Another point brought out in the discussion, was the importance of taking precautions to prevent any over-strain on the bolts when tightening up, and it was suggested that some form of gauge should be employed to note the elongation caused by the bolting up of the nut.

Patent Applications.

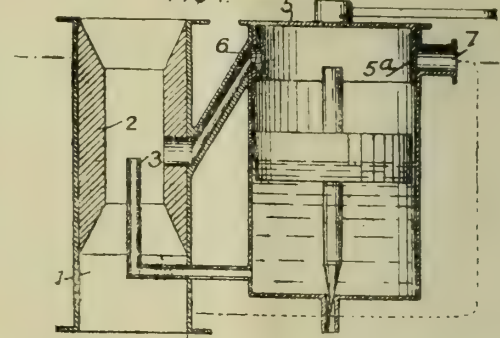
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts o Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

122,848.—F. Smal, Couthuin, Belgium.—Jan. 27th, 1919.—In spray carburettors having one or more mixing chambers 1 each containing one or more nozzles 3, the flow of fuel from the nozzle or nozzles is controlled by providing two apertures 6, 7 in the float chamber above the fuel level, one aperture 7 opening into the

FIG I.

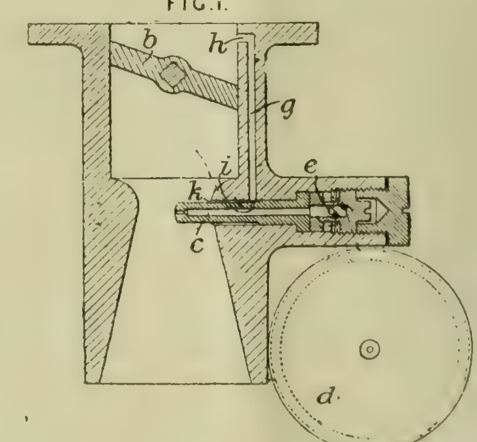


atmosphere or, as shown in dotted lines, into the air intake, the other being connected to the interior of the choke tube 2 near the nozzle outlet. The apertures 6, 7 are controlled by a rotatable valve 5*a* formed in one with the cover 5. The ports in the valve are so arranged that either of the apertures 6, 7 may be fully open alone, or both partly open together. The mixing chamber may be provided with a throttle valve on the air inlet or engine side of the nozzle.

INTERNAL-COMBUSTION ENGINES.

123,094.—H. Bedet, 14, Galvani, and M. M. Baudelocque, 46, Boulevard Raspail, both in Paris.—Feb. 6th, 1919.—In carburettors provided with a main sprayer and a bye-pass or slow running sprayer, an additional sprayer is provided to supply fuel during the period of "picking up" and until the main sprayer is in action. The main sprayer *c* is fed from the float chamber *d*

FIG.1.

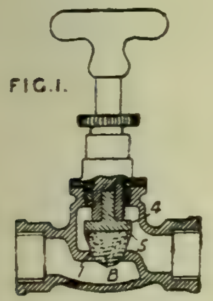


through an orifice *e*, and has in its wall a calibrated orifice *i* which is above the constant level and delivers into an annular passage *k* which surrounds the main sprayer and communicates with the bye-pass *g* which delivers at *h* on the engine side of the throttle valve *b*. With the throttle closed, air and fuel enter the passage *g* and keep the engine running slowly. On opening the throttle the flow of the emulsified fuel is reversed and it is discharged through the passage *k* and serves to keep the engine running until the suction is sufficient to bring the sprayer *c* into action

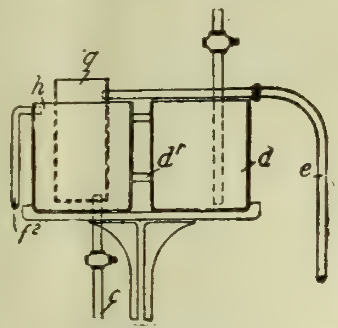
VALVES.

122,935. G. A. Burridge, 198, Moseley Road, and J. J. Hackett, 52, Paradise Street, both in Birmingham. Feb. 22nd, 1918. A self-

grinding screw-down lift valve comprises a valve member B of natural or artificial stone, such as fine Turkey oilstone, which will grind and bed itself to a metallic seating 1. The valve member is preferably dome shape, as shown, and is fixed in a metal holder 4 by an interned flange 5.



Patent 122,935.



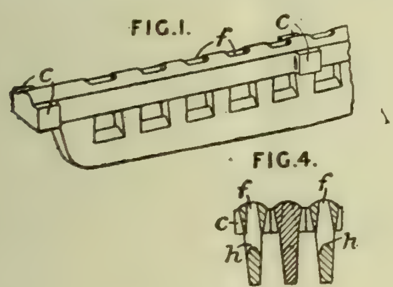
Patent 122,952.

LUBRICATING.

122,952.—T. KING, 97, High Street, Penistone, Yorkshire.—Sept. 4th, 1918.—A device for cooling lubricating oil in connection with an enclosed shaft bearing comprises two water tanks *d*, *h* side by side, one of which contains an oil tank *g*. Water is supplied to the tank *d*, passes by pipes *d*1 to the tank *h*, and escapes by a pipe *f*2. Heated oil ascends from the bearing by a pipe *e* to the tank *g* and cooled oil returns to the bearing through a pipe *c*.

FURNACES.

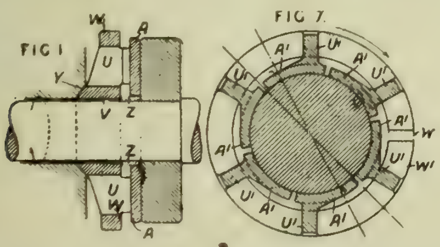
123,001.—E. H. GRIFFITHS, 320, Great Cheetham Street, Higher Broughton, Salford.—Aug. 6th, 1918.—Bars having rounded top surfaces are formed with slots *f* of tapering form, wider below than above, and having openings to both sides of the rib, the lower faces of the openings being inclined upwardly to a rounded



edge *h* as shown. The slots of adjacent bars are arranged in staggered relationship, the intervening portions of the bars being of substantially the same length as the slots. The side faces of the bars are inclined, and spacing lugs *c* are formed thereon, so that when the bars are assembled tapered slots are formed between them.

BEARINGS.

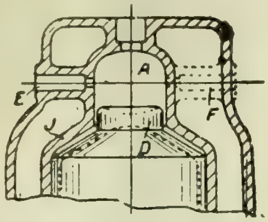
123,010.—A. G. M. MITCHELL, 450, Collins Street, Melbourne, Australia.—Feb. 2nd, 1918.—A thrust or journal bearing for shafts, etc., consists of an annular series of flexible sections A, A1 of varying thickness connected integrally by supports U, U1 to two concentric rings V, W. The sections yield slightly under the load and admit a film of oil between the bearing surfaces. The thrust



bearing shown in Fig. 1 may be spherically seated at Y. The ring V is extended at Z to prevent leakage of oil along the shaft. Fig. 7 shows a journal bearing in which the supports U1 are connected to two end rings W1 seated spherically in a housing. A gap *w* enables the bearing to be adjusted for wear. Specifications 875, 1905, 23,496, 1911, and 115,804 are referred to.

INTERNAL-COMBUSTION ENGINES.

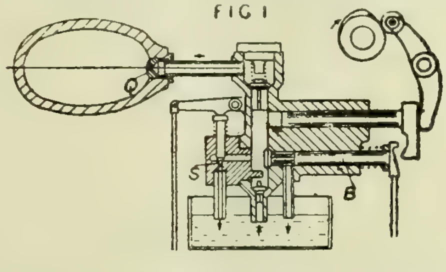
123,442.—SIR K. I. CROSSLEY, and W. LE P. WEBB, Openshaw. Manchester.—April 8th, 1918.—The combustion chamber A of a two-stroke cycle engine is about half the diameter of the cylinder and has a hemi-spheroidal end. The end D of the piston projects



into the combustion chamber, its face being curved or flat. The wall J of the cylinder merges gradually into that of the combustion chamber. There are two fuel nozzle sockets E, F.

INTERNAL-COMBUSTION ENGINES.

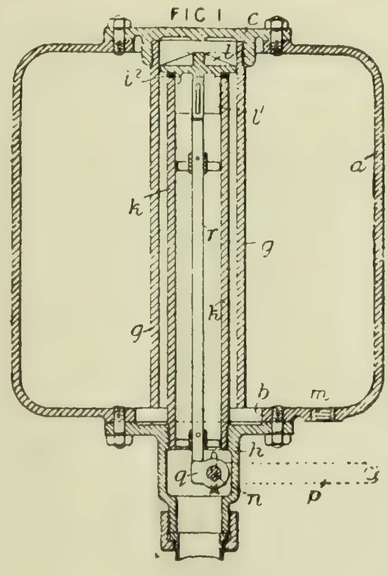
123,443.—SIR K. I. CROSSLEY, and W. LE P. WEBB, Openshaw, Manchester.—April 10th, 1918.—The fuel is delivered through the nozzle Q at an approximately uniform velocity, although the speed of the engine and consequently the delivery of the oil



pump may vary. The pump shown in Fig. 1, and described in Specification 21,043, 1911, is used and is fitted with a hand or governor controlled relief valve S which is opened at high speeds and closed at low speeds, or the pump may deliver through two nozzles at high speeds and one at low speeds. The valve S may be a piston valve which uncovers ports in succession. The valve B adjusts the supply of oil delivered according to the load.

WATER-WASTE PREVENTERS.

123,452.—L. DAVIES, 55, King's Avenue, New Malden, Surrey.—May 31st, 1918.—A water-waste preventer comprises a siphon arranged within an air-tight vessel *a* connected to the service pipe at *m*, the siphon being opened to allow the water in the vessel *a* to pass into the flush by an externally-operated valve. The siphon consists of a short leg *g* screwed into a bolted-on cover

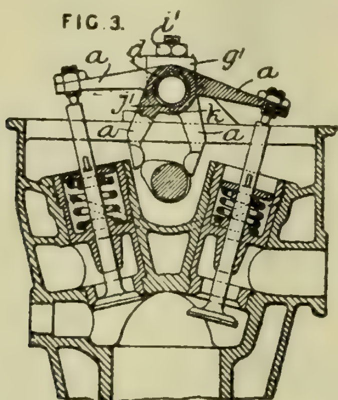


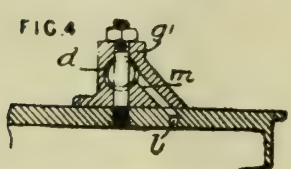
c, and a long leg *k* screwed into a casing *h* which closes up a bottom opening *b*1 in the vessel *a*. The valve *l* consists of a piston sliding in the leg *g* and guided by fins *l*1 engaging the leg *k*, packing *l*2 being conveniently provided. The valve *l* is raised to start the flush by a rod *r* guided in the leg *k* and moved upwardly by a cam *q* mounted on a shaft *n* passing through the casing *h* and turned from the outside by a lever, etc., *p*. The water is forced through the siphon by the pressure in the service pipe and

by the compressed air in the vessel *a*, and the valve *l* is kept open during the flush by the flow of water underneath it, and closes by gravity when the flow slackens.

INTERNAL-COMBUSTION ENGINES.

123,528.—F. P. L. DOUTRE, 16, Rue des Ursulines, St. Denis, Seine France.—Feb. 11th, 1919.—To facilitate removal and replacement, the valve levers *a, a* for the inlet and exhaust valves are mounted on a single shaft *d* which is supported in two brackets *g*1, each secured by a nut and stud. The shaft and rocker-arm assembly

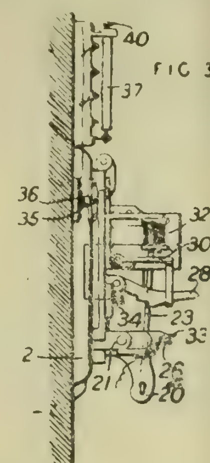


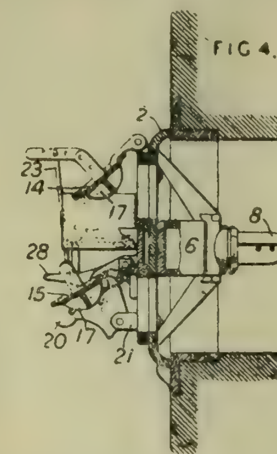


can be removed by unscrewing the two nuts *i*1. The valve levers for adjacent cylinders are separated by distance sleeves on the shaft *d*. The shaft *d* supporting the valve levers is hollow, and receives oil under pressure from a passage *l* which registers with a passage *m* in the bearing *g*1 when the parts are assembled. The oil passes through holes *j*1, Fig. 3, to the bearing surfaces of the valve levers, and is projected on to the cams through orfices *k* in the bosses of the valve levers.

FURNACES.

123,560.—L. D. WEST, Hotel, West-Court, Denver, Colorado, U.S.A.—Feb. 20th, 1918.—Dampers on the door of a furnace are opened by a handle, and are closed after a predetermined time abruptly, preferably electrically. Figs. 3 and 4 show a door 2 with the air heating and supplying fitting 6, 8 described in Specification 123,559, and with dampers 14, 15, braced by crossed webs 17, and connected by a link so that they are moved together





by a link 23 attached to the handle 20, which is pivoted to a lug 21 on the door. As the handle 20 is raised, its nose 26 engages with one of the teeth on a latch 28, which may be released manually in order to close the dampers 14, 15. As arranged, the latch 28 may be released electrically by an armature 30, which is lifted by an electro-magnet 32 energised by the completion of circuits by means of switches 33, 34 and 35, 36 closed respectively by the raising of the handle 20 and the closing of the door. The circuit is also controlled by a column 37 of mercury heated electrically by a circuit completed when the door is shut and the dampers opened. The expanding mercury makes contact with a set-screw 40, completes the circuit round the magnet 32, and releases the handle 20, thus abruptly shutting the dampers.

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THE Industrial Engineer.

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CONTENTS.

EDITORIAL.

TRAINING IN ENGINEERING UNDER THE SCHEME ADMINISTERED BY THE APPOINTMENTS DEPARTMENT.

THE Ministry of Labour thinks it desirable to make the following announcement in order to explain to candidates for training and to the public the reasons why there has been difficulty in giving training under the Training Grant Scheme in the engineering trades, and to remove any misunderstandings which may exist in the minds of members of the trade unions concerned.

This Training Grant Scheme was devised in the interests of resettlement to restore the supply of men of higher professional, business and technical attainments, by selecting for training at State expense ex-service men whose preparation for civil careers has been prejudiced by their war service, and whose family circumstances do not permit of their undertaking training at their own expense.

This Training Grant Scheme covers practically all professional, commercial and business occupations. In the interests of the nation and of the individuals concerned, it is considered that ex-service men should not be debarred from entry into any trade or profession, and it is not apparent that there is any adequate reason why an exception to this general rule should be made in the case of the engineering trades.

Practically every industry and calling has shown its willingness to take its share of ex-service men for training, and in almost every case special concessions as regards their entry into the trade or profession have been made.

The engineering training given under the scheme, is in no way intended to qualify men to compete with journeymen in the trade, but its object is to qualify them mainly for the commercial or office side.

The engineering trade unions objected to the introduction of the scheme on three principal grounds.

(1) That the trainees under the Appointments Department Scheme would fill the better positions in the industry to which the ordinary industrial apprentices would aspire.

(2) That many industrial apprentices were still with the colours, and many trade unionists were out of work.

(3) That the scheme would "militarise" the factories.

To meet these objections certain modifications of the original scheme were proposed by the Ministry, and these have for some time been under consideration by the trade unions.

As regards the number of trainees, it is suggested that this should not exceed 1,750, which is less than one-third per cent of the total membership of the engineering trade unions. As a further safeguard, the number of trainees in any one factory would not exceed one per cent of the total number of employees in the works.

Most of the engineering trade apprentices are now demobilised, and to ensure that the trade should not be overcrowded with trainees from other industries, it is proposed that, except in the cases of the disabled, the only candidates who will be considered for grants are those who, previous to their war service, had not entered upon civil careers in any trade or profession other than engineering.

The machinery through which candidates are selected for training under the scheme consists of interviewing boards sitting in all the principal towns of the United Kingdom. In order to ensure that no trade union principles are infringed, it is proposed that the engineering trade unions should nominate representatives to sit on these boards.

In a large proportion of cases, the parents of the applicants belong to the working classes, and their sons, without State assistance for training might be compelled to drift into the unskilled labour market.

It is thought that the misconceptions which have existed in the past can be removed if it is made clear to the members of the trade unions concerned that men in needy circumstances, and in some cases their own sons, may be selected to enjoy the benefits of this scheme, and so may qualify for positions which without this assistance would have been out of their reach.

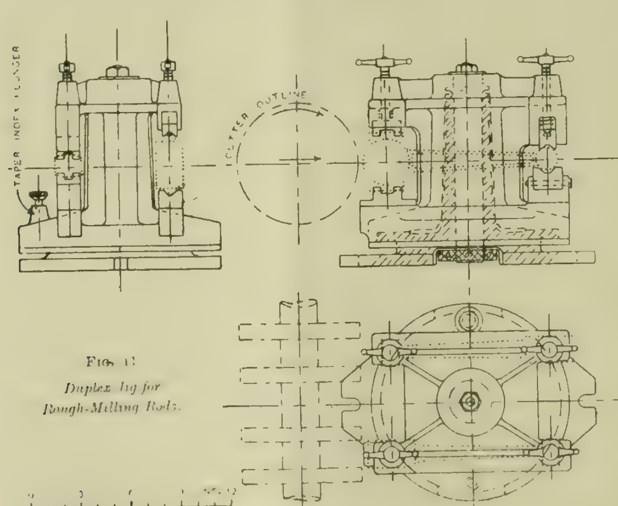
JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By HERBERT C. ARMITAGE, of Birmingham, Associate Member.

(Continued from page 91.)

Mill Both Ends of Connecting-Rod (FIG. 11).

There are four cutters used with this jig, and it should be noticed that the method applies whether the small boss of the connecting rod is wider or narrower than the large end. The cutters are fed up to the rods in the same way as in the jig described in the smaller scheme, and after having taken the cut it is indexed round through 180 deg. The general

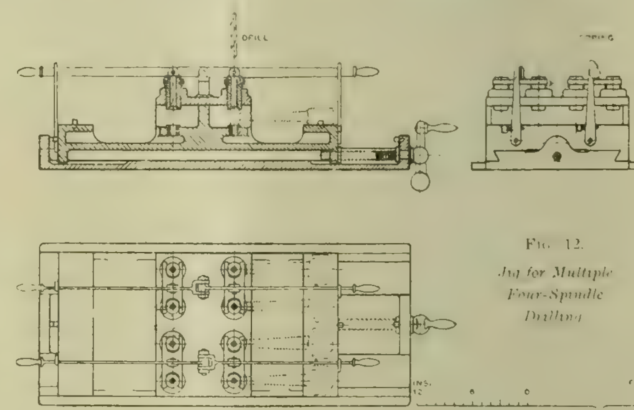


JIGS, TOOLS, ETC.—FIG. 11.

disadvantage of jigs of this type is that very exact workmanship is required, in order to achieve accurate results, as a small inaccuracy in their alignment is magnified in the work. Owing to the height of the work above the machine table, a special construction has been arranged to obtain the necesary stiffness. The base plate is built up in the form of an internal taper-sleeve, inside the indexing portion, which takes the entire thrust of the cutters. Clamping in position is effected by means of a "tommy bar" in the base of the structure. Additional support is given by the annular slide strip which goes right round the revolving portion. To obtain the maximum production two jigs would be mounted upon the table of one machine, with the cutters in between the two jigs. It would mean alternate directions of feed for the table, and in one case the cutters would have to cut upwards; with the stiff construction shown, it should, however, be possible to obtain accurate work. One jig would be loaded whilst the cutters were at work on the opposite fixture, but it is questionable whether a jig of this type is preferable to three or four jigs which could split the operations up into their simplest parts. By doing this there would be no approach to continuous cutting, but the actual time of operation would be very much reduced.

Drill Small End of Connecting-Rod (FIG. 12).

This jig will drill four connecting rods at once, with the minimum of trouble in placing them in the tool. While they are being drilled on one side of it, four other connecting rods are being loaded on the other side. In some drilling machines it is possible



JIGS, TOOLS, ETC.—FIG. 12.

to move the table lengthways to fixed stops, so that the screw and hand wheel which are here embodied in the jig will not then be necessary. It will be observed that the bushes are moved up and down in a very rigid guide by means of a long handle which will be sprung down against a latch at the end of the handle. This form of construction is better and quicker than the screw-down bush. The spring in the lever should be sufficient to hold the handle up to the latch. In the illustration, the holes are perhaps shown closer together than would be practicable, but this makes no difference to the essential design of the jig.

Drill Large End of Connecting-Rod.

This jig is practically the same in design as the previous one, except that the connecting rods would be positioned from the small hole. These two last-named jigs represent the nearest that can be obtained to continuous drilling without the aid of special machine tools, but each of them will keep one man per machine fully occupied in loading and unloading one jig.

Drill Bolt-Holes and Centre End of Connecting-Rod (FIG. 13).

This jig is intended for use in a multiple-spindle drilling machine, and there should be at least four drilling spindles and two centreing spindles at work at once to effect any economy. The jig will be indexed round by hand, and the sleeve support construction is again worthy of note.

Table 5.

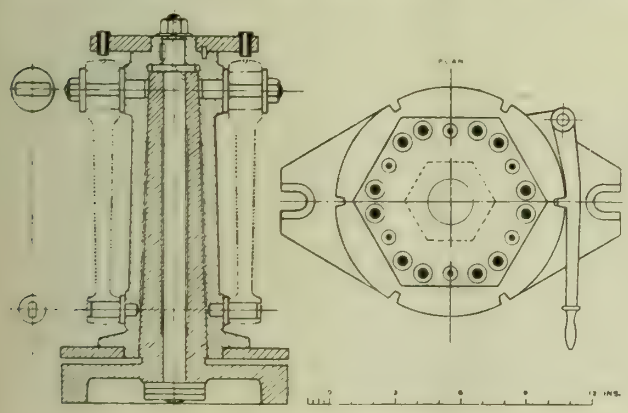
SCHEME FOR MAXIMUM PRODUCTION.

Output = 60 per hour = 3,000 per week.

Operation No.	Description of Operation.	Fig. No. of Jig.	Time Required Minutes. per Piece.	Type of Machine.	No. of Machines.	Labour Cost per Piece. Pence.
1	Heat treatment	—	—	—	—	—
2	File burrs, &c.	—	-	—	—	—
3	Continuous mill both ends of rod	Plate 1	1	2-Spindle Circular Miller.	1	0·2
4	Continuous drill both ends of rod	14	1	4-Spindle Auto Drill.	1	
5	Broach small end	—	½	Broaching.	1	0·1
6	Continuous drill and centre	15	1	2-Spindle Double Drill.	1–2 Head	0
7	Continuous mill sides of rod	16	1	Duplex Continuous Miller.	1	
8	Mill across top of bolt-holes	—	5	Horizontal Miller.	5	0·9
9	Mill sides of bolt faces	17	2	Duplex Vertical Miller.	2	0·4
10	Part cap	-	5	Horizontal Miller.	5	0·9
11	Finish bore large end		20	Turret Lathe.	20	3·3
12	Run white metal in large end		-	—	-	—
13	Finish bore white metal in large end		10	Turret Lathe.	10	1·7

Mill Sides of Connecting-Rod.

This operation will have to be done in practically the same manner as the one shown in the last scheme, but it is possible that economy might be effected by putting six or eight rods in a line, and running a facing cutter across them at the full width of the surface between the bosses. There would, however, be difficulties in giving an adequate support to the middle of the connecting rod, without complicated construction. Separate carriers to be loaded whilst the cut is in progress should be provided.



Jigs, Tools, etc.—Fig. 13.

Finish Boring Large Hole.

The remaining operations are the same as in the first scheme except that the finish boring should be done on a heavy gap bed-turret lathe of the "Gisholt" type. Also the finish boring for white-metalling will require an equally substantial machine in order to get the swing necessary, but would have a disadvantage in rendering back gear useless, on account of the speed required. There is one method, however, in connection with the finished boring that might result in economy, and that would be to bore the connecting rods on a drilling machine by means of a single inserted tool piloted boring bar, then changing the bar, putting in a recessing tool holder, and finishing off with a reamer. The accuracy of the finished boring is not of vital importance when the connecting rod has to be white-metalled, and if the finish is slightly rough it will make the white metal hold even better. The practice is not to be recommended if turret lathes are available.

Scheme for Maximum Production.

In this scheme it is proposed to investigate the possibilities of continuous cutting with special machine tools, and the lay-out is given in Table 5.

Mill Ends of Connecting-Rod.

There are two vertical spindles, and the internal cutters will move in the smallest circle possible. The machine will not have to be stopped for loading, and there will be a continuous production from the machine. Unfortunately, when continuous cutting is adopted, there are several disadvantages, the principal one being that of getting the cutters to stand up effectively to the work. A machine of this description is usually more powerful in strength and feed than can be reasonably expected from the cutters. Also since the best of cutters will become dull in four to five hours, there is a considerable waste of time in changing them, and several spare sets must be kept in readiness. Assuming that the machine tool turns out connecting rods at the rate of 60 per hour, and that there is a stoppage of work for 30 minutes at the very least, to change cutters, it means a loss of output of about 40 connecting rods during that time. Considering that this will take place twice a day, it makes a very serious drawback. There is usually a similar trouble experienced in holding the pieces in continuous milling, as in multiple-operation machines. In the photograph, Plate 1, there is shown an illustration of a Becker double-spindle continuous miller set up on connecting rods, where the design of jig employed is decidedly ingenious. The Becker Company claim that they can mill up to 90 connecting rods per hour, but the output must depend mainly upon the degree to which the rods have been previously annealed and pickled to remove scale.

(To be continued.)

"BRISTOL" AEROPLANES.

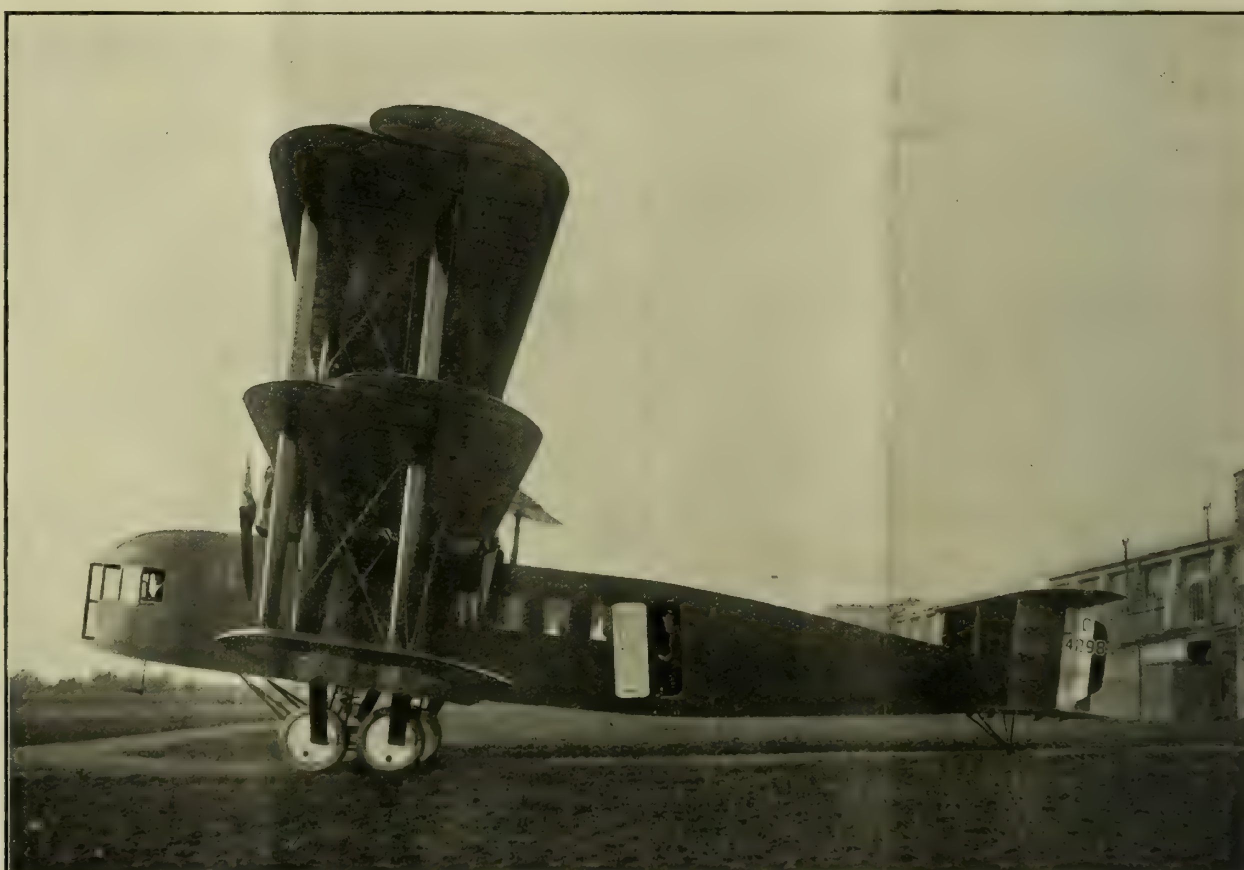
We have received the following particulars concerning "Bristol" Aeroplanes, which the British and Colonial Aeroplane Company Limited are exhibiting at the International Aerial Exhibition, which opened in Paris on December 19th, 1919:—

The "Bristol" Pullman Triplane.

Amongst the large aeroplanes constructed to provide a high-speed machine capable of carrying a considerable load of passengers and cargo in addition to fuel for a lengthy flight, the "Bristol" Pullman Triplane occupies a position apart. The four 410 H.P. Liberty engines, with which it is fitted, ensure absolute reliability and safety, whilst the tasteful and luxurious appointments of the roomy Pullman ensure the highest comfort a traveller may desire.

The car in which the 14 passengers carried, in addition to the pilot and engineer, are accommodated is seven feet in height, and wholly enclosed. A central gangway affords access to the comfortable *fauteuils* which, though removable, are normally placed on either side of the car. Large triplex glass windows are provided for the convenience of each passenger, and an adequate system of heating and lighting by means of electricity is installed. The question of ventilation has also been carefully studied.

Any, or all of the seats may be removed for the conveyance of mails or cargo, and a total space of 570 cubic feet can thus be made available. In addition to the two pilots, the machine is capable of lifting a load of 2,700 lb. with fuel for five hours' flight, or alternatively, 4,000 lb. with fuel for 2½ hours flight. These figures are based on an economical speed of from 100 to 105 miles per hour, *i.e.*, at three-quarter throttle giving a sufficient reserve of power to reach a maximum speed of 125 miles per hour, if necessary.



The "Bristol" Pullman Triplane.

Specification.

Weights and Dimensions—

Weight empty, 11,000 lb.
Weight loaded, 17,750 lb.
Wing span (top plane), 81 ft. 8 in.
,, (centre), 81 ft 8in.
,, (bottom), 78 ft. 3 in.
Chord of wing, 8 ft. 6 in.
Wing area, 1,905 square feet.
Wing loading, 9.3 lb. per square foot.
Overall length, 52 ft.
Maximum height, 20 ft.
Petrol capacity, 430 gallons.

Performances—

Best speed, 125 miles per hour.
Cruising speed, 100 miles per hour.
Landing speed, 55 miles per hour.
Climb to 5,000 ft., 5 minutes.
,, 10,000 ft., 12 minutes.
Ceiling, 15,000 ft.
Range, 525 miles.

The "Bristol" Bullet.

This single-seater machine is designed primarily for racing purposes, and is fitted with a 450 H.P. Cosmos "Jupiter" air-cooled radial engine. Exceptional strength is the outstanding feature in the design, and to attain this object double spars are fitted throughout, even in the wings and tail. As a result, any evolution can be carried out with perfect safety at the maximum speed of 160 miles per hour.

SPECIFICATION.

WEIGHTS AND DIMENSIONS—

Weight empty, 1,700 lb.
Weight loaded, 2,300 lb.
Wing span (top wing), 31 ft. 2½ in.
" (bottom wing), 29 ft. 2½ in.
Chord of wing (top wing), 5 ft. 11 in.
" (bottom wing), 4 ft. 11 in.
Wing area, 294.6 square feet.
Wing loading, 7.82 lb. per square foot.
Overall length, 24 ft. 1 in.
Maximum height, 9 ft. 8 in.
Petrol capacity, 50 gallons.

PERFORMANCES—

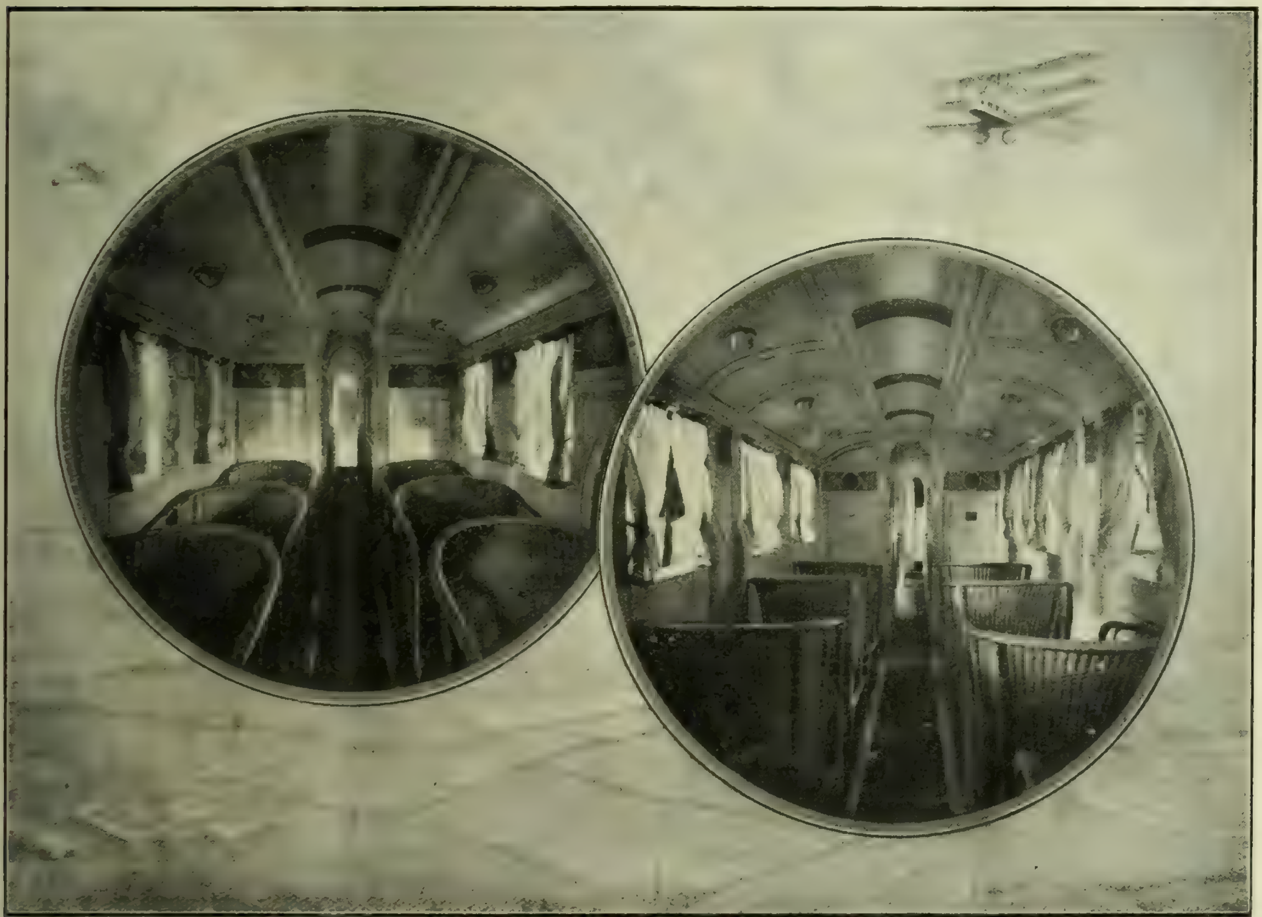
Best speed, 160 miles per hour.
Landing speed, 50 miles per hour.

The "Bristol" Tourer.

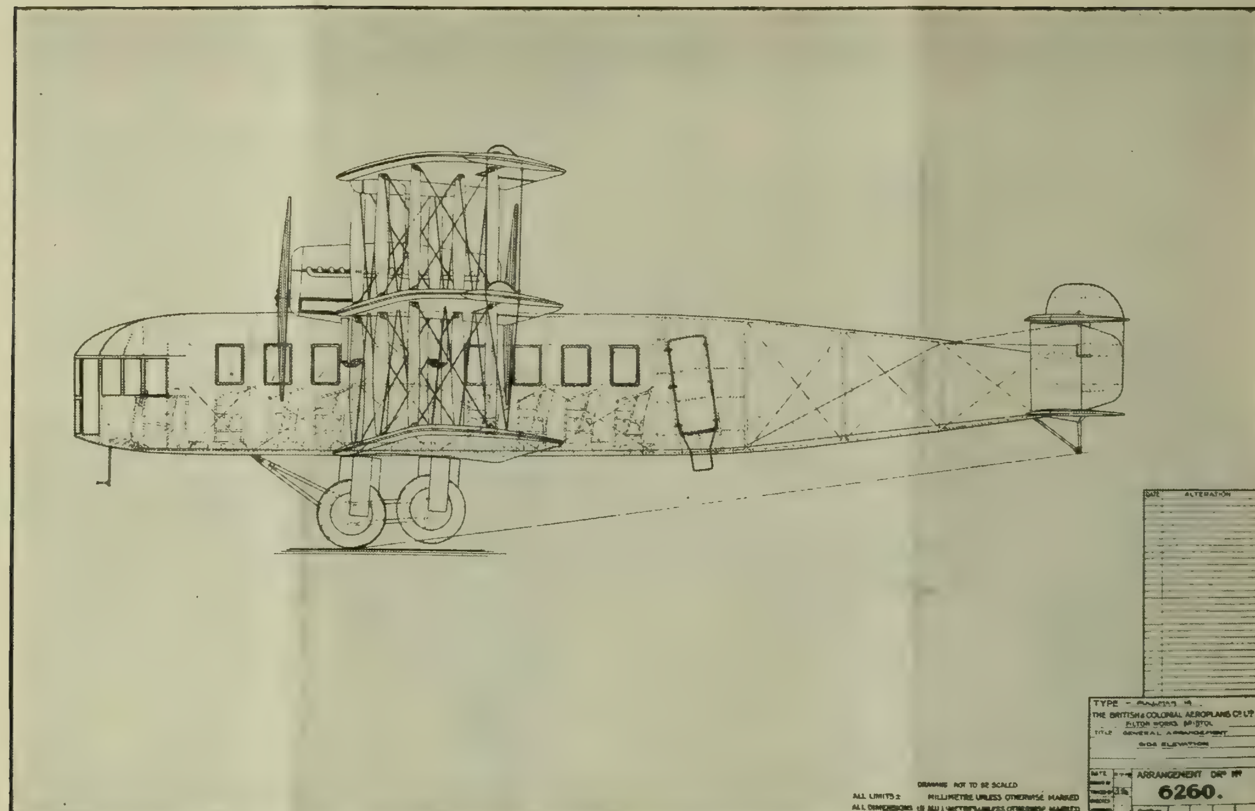
Designed primarily to provide a machine of great dependability, and capable of maintaining a fairly high speed for a considerable period of time, the "Bristol" Tourer has proved a great success. Its petrol tanks, which carry 70 gallons, are sufficient to allow of the machine remaining in the air for a distance of about 560 miles.

Dual controls are normally fitted to enable the passenger to take over the pilotage during a lengthy flight if desired, although the machine can be supplied fitted with pilot's controls only. When used for the transport of mails or cargo, a load of some 300 lb. can be carried, in addition to the pilot and full complement of fuel and oil, although this weight can be increased should it be desired only to carry fuel for a shorter range of flight. The machine can be fitted either with a 275 H.P. Rolls-Royce Falcon III. engine, or with a 230/240 H.P. Siddeley Puma engine. Fitted with the former, the machine can attain a speed of about 125 miles per hour, with a normal cruising speed of about 90 miles per hour. When the latter engine is fitted the maximum speed is 120 miles per hour, and the cruising speed 85 miles per hour. With either engine the petrol consumption for the distance traversed is the same, although taking into consideration the difference in speed, the consumption with the Rolls-Royce engine is 15½ gallons per hour, and with the Siddeley Puma 15 gallons per hour.

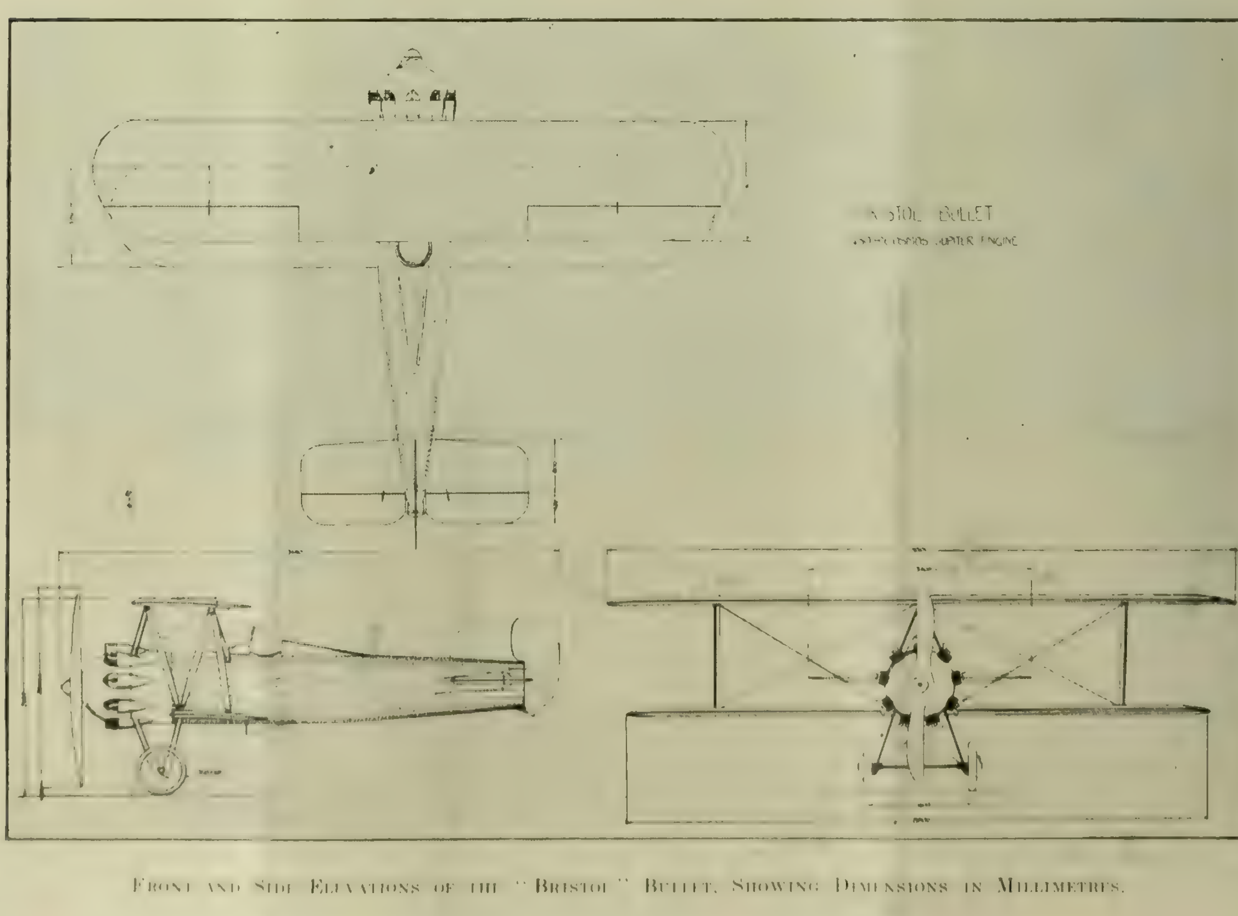
The "Bristol" Tourer follows much upon the lines of the renowned "Bristol" Fighter, and is designed to meet the continual demand which is



INTERIOR OF "BRISTOL" PULLMAN TRIPLANE.

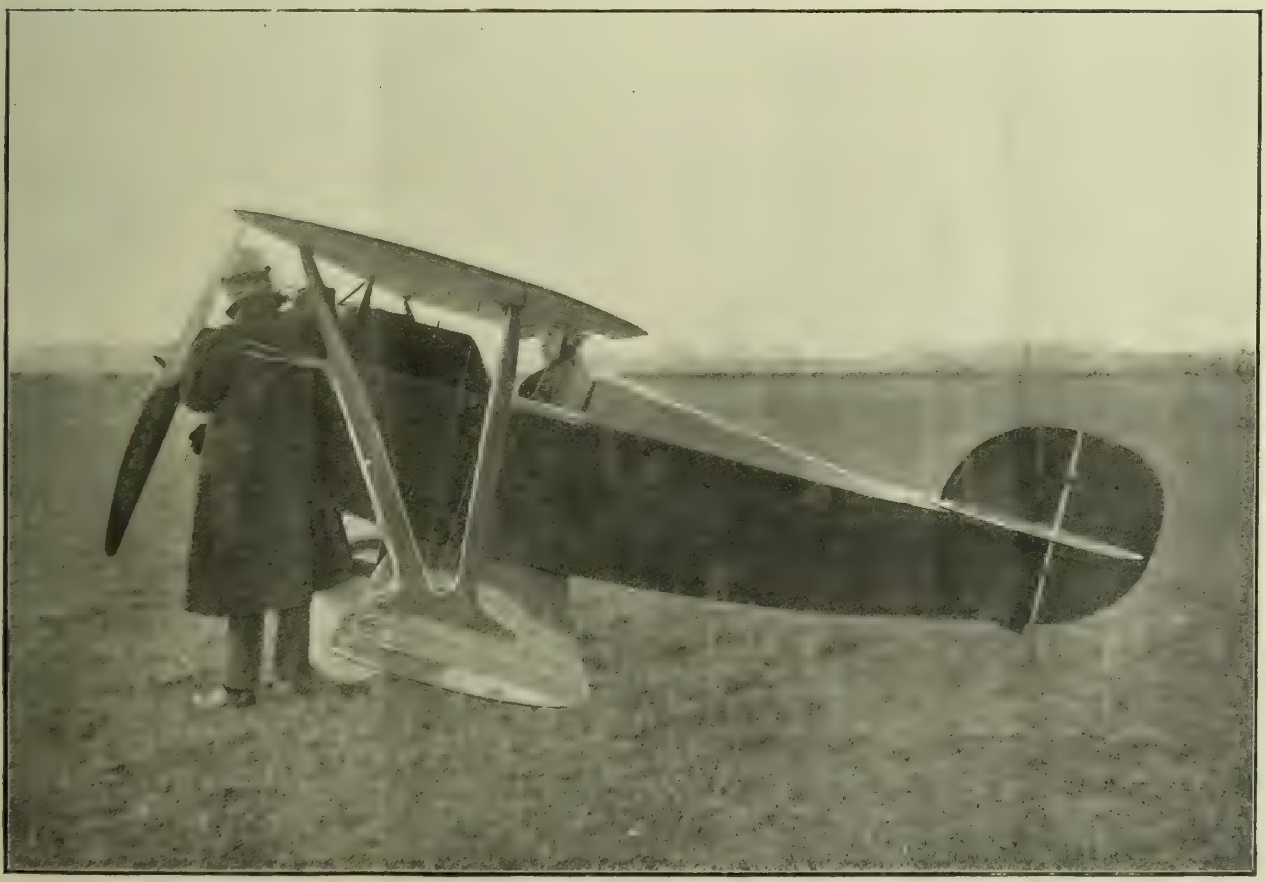


View Showing General Arrangement of the "Bristol" Pullman Triplane.



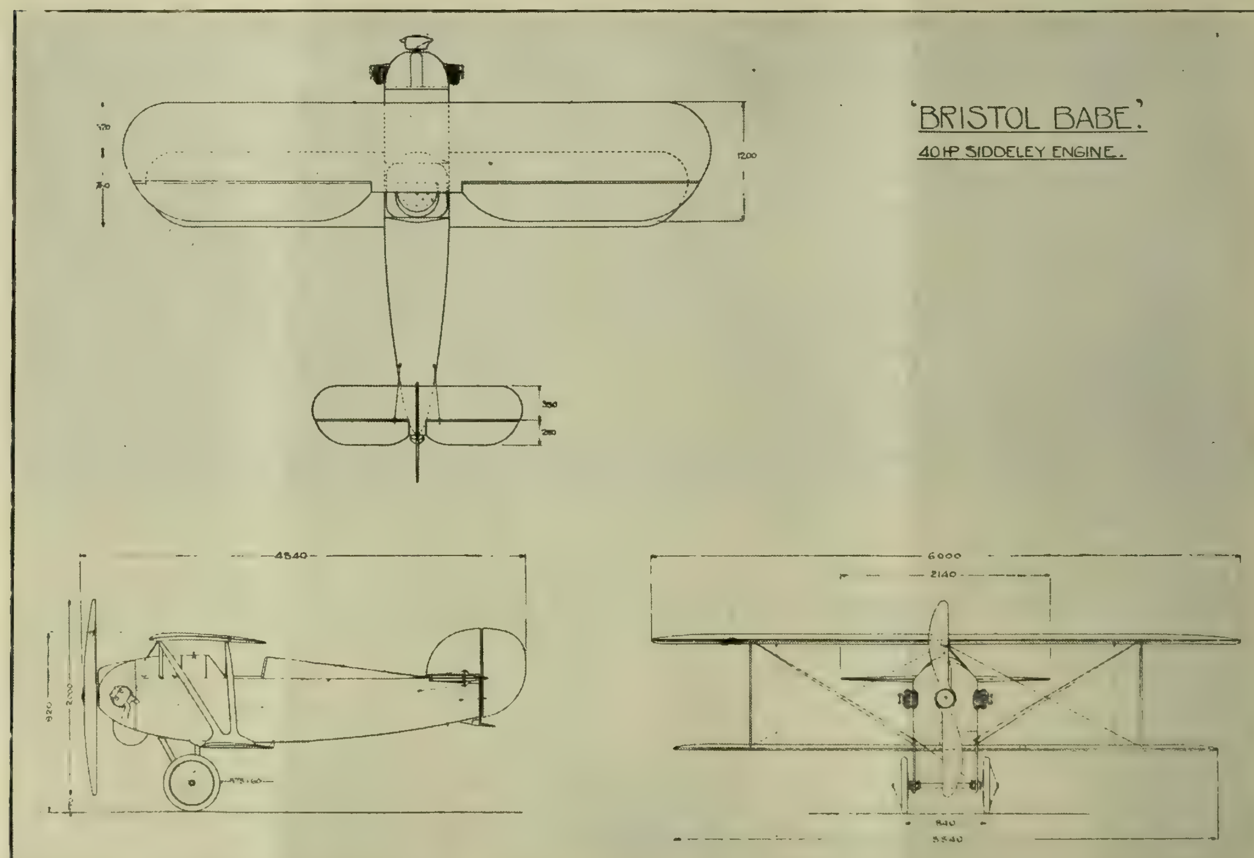
Front and Side Elevations of the "Bristol" Bullet, Showing Dimensions in Millimetres.

The "Bristol" Tourer Biplane. 230-240 H.P. Siddeley Prima Engine.



The "Bristol" Babe

being made for this type of machine. It is offered to the public at the exceedingly low price of £1,200, this figure being rendered possible by the fact that, owing to the concellation of war contracts, considerable quantities of high-class material have been left upon the manufacturers' hands, and this material is being embodied in the "Bristol" Tourer. The "Bristol" works are also highly organised for the production of this type of machine, and it is anticipated that the considerable demands which this price will entail will do much to keep the production costs at the lowest possible level.



Front and Side Elevations and Plan of the "Bristol" Babe, Showing Dimensions in Millimetres.

Specification.

Weights and Dimensions—

Weight empty, 1,750 lb.
Weight loaded, 2,800 lb.
Wing span, 39 ft. 3 in.
Wing area, 405 square feet.
Wing loading, 6.92 lb. per square foot.
Chord of wing, 5 ft. 6 in.
Overall length, 25 ft. 9 in.
Maximum height, 10 ft. 1 in.
Tankage—Petrol, 70 gallons.
Ceiling, 20,000 ft.

The "Bristol" Babe.

The "Bristol" Babe has been constructed to meet the demand for a small single-seated aeroplane, in which the costs of upkeep and the actual running costs are reduced to the absolute minimum.

The fuselage is constructed throughout of three-ply wood, without any bracing wires, whilst the tail is on the cantilever principle, and also without bracing wires. The main planes are braced with duplicate cables. With a maximum width of 19 ft. 8 in., an overall length of 14 ft. 4 in., a height of 5 ft. 9 in., and a weight of only 460 lb., the machine can easily be handled by one person, whilst it can be housed in a medium-sized garage. By reason of its structure, the minimum amount of overhaul is necessary.

Fitted with a 40 H.P. two-cylinder air-cooled Siddeley engine, the petrol consumption is only about 3 gallons per hour when a full speed of 80 miles per hour is maintained at a height of 5,000 feet. The economical cruising speed is about 65 miles per hour. For landing and taking-off purposes the area required is quite small, whilst sufficient petrol can be carried to allow of a flight of 160 miles at full speed.

Specification.

Weights and Dimensions—

Weight empty, 460 lb.
Weight loaded, 683 lb.
Wing span (top wing), 19 ft. 8in.
" (bottom wing), 18 ft. 8 in.
Chord of wing (top wing), 3 ft. 11¼ in.
" (bottom wing), 2 ft. 6 in.
Wing area, 107.8 square feet.
Wing loading, 6.34 lb. per square foot.
Overall length, 14 ft. 11 in.
Maximum height, 5 ft. 9 in.
Tankage—Petrol, 6.5 gallons

Speeds—

Best speed at 5,000 ft., 80 miles per hour.
Cruising speed at 5,000 ft., 65 miles per hour.
Landing speed, 40 miles per hour.
Ceiling, 10,000 ft.

Shipping Measurements—

This machine can be shipped complete in one case measuring 6 ft. × 6 ft. × 21 ft.

THE INDUSTRIAL SITUATION.

A Strong Undercurrent of Unrest.

The comfortable assurance of Mr. Lloyd George that the industrial position is very much improved, is most unfortunately not verified by facts. The fact that no great national service is suffering semi-paralysis owing to strikes, does not necessarily mean that there is no serious unrest in the world of industry. Though there is a calm on the surface, there is a very strong undercurrent; and this is the more dangerous from the fact that it is not apparent to the casual observer.

Widespread Dissatisfaction.

In the engineering trade there is widespread dissatisfaction at the award just promulgated. And this is due to the fact that, irrespective of what those in authority say anent the decrease in the cost of ilving, that there never was a period when, taken all round, prices were so high as they are at the present moment. Side by side with this fact, there never was a time when the purchasing power of engineers as a class was so low.

The Price of Commodities.

Taking the Manchester district as a typical example, we find that the prices of commodities absolutely necessary to the maintenance of the workers and their families have risen until to-day they stand at prices which mean 130 per cent on those of June, 1914. On the other hand, wages which were on an average of 39s. per week in 1914 will only average when the new award is included 73s. per week, or an equivalent to 87 per cent over pre-war rates. It does not require very much calculation to show that, in this district at any rate, the working engineer is in the position of being much worse off than he was prior to the war. On the other hand, he discerns evidences of the wealth which the war has brought into the coffers of his employers. He sees on every hand concerns which were on the verge of bankruptcy in 1914 flourishing as the green bay tree in 1919.

The Extension of Plants.

Firms on every hand have extended their operations, increased their plant and buildings, and in many notable cases have capitalised considerable proportions of their reserve funds, and the worker knows that this is the outcome of the great prosperity engendered by the war. Further, he finds out that, as a result of the waste, incapacity, and extravagance of the Government, he is being taxed upon wages which, in purchasing power, are only equivalent to 34s. per week.

Seething with Discontent.

These remarks apply generally to the engineering industry, and, as one who has the opportunity of ascertaining the views of scores and hundreds of the men in question, I have no hesitation in saying that the whole of the trade is seething with discontent. That this discontent will lead to some violent eruption in the near future goes without saying, and the prospects of a merry yuletide are growing ever more remote.

The dispute between the employers and the ironfounders still drags on, and, as a result, the figures relative to unemployment are rapidly rising, and ere long this will become an important factor in the shaping of future events.

No Real Remedies Sought.

I have no desire to fill the role of Jeremiah, but the prospect is none too alluring. The disease is spreading, and no attempt is being made to check it. No real remedies are being sought out or applied, and the result may be that it will become incurable.

In previous articles I have outlined what I firmly believe is the only real and effective way of bringing about industrial concord, and that is the establishment of joint boards of employers and workmen, untramelled by either Government or Trades Union control. It should not be a difficult matter for an industry like that of engineering to find a score of intelligent men, from both sections, who could arrive at, and educate their constituents into accepting, an arrangement agreeable to both sides, practicable when put into operation, and based upon lasting and just principles.

The present award to the engineering and allied trades is certainly not of the sort that will stimulate production, but I am afraid it will have the very opposite effect.

Increase Production.

If production is to be increased, it will mean more effective organisation, more up-to-date methods, and, above all, better remuneration. The workers are ready to produce more, and are capable of doing so, but they ask, and very pertinently too, "Where do we come in?" That is the question which will have to be answered without equivocation or reserve. Failing such an answer, production will not be materially increased, but there will be distrust and suspicion, with the consequent unrest and strife.

Lord Milner, in a recent speech, begged of the workers "not to put grit into the wheels of the industrial machine," and that is sound advice, but, as Robert Blatchford put it in a recent article, we must at the same time "see that no dirty knave purloins the lubricating oil." One and the same effect would be the ultimate result of either action.

A few weeks ago, along with a companion, I stood one evening at Piccadily Circus, watching the almost incessant stream of motors and taxi-cabs roll by. Both I and my companion were thunderstruck at the vulgar and ostentatious display of wealth that we witnessed. Every vehicle contained bejewelled women and immaculately dressed men, all on pleasure intent, and my companion remarked, "Judging from what we see, a lot of people seem to have done well out of the war." The remark was justified, and one could not help but wonder where we were travelling as a community, and what the ultimate end would be.

To those who are not too dense to learn, the signs and portents of the present time are unmistakable. Let me name but a few.

A Competent Leader.

The election of Mr. Tom Mann to the position of General Secretary of the A.S.E. is a fact significant of many things. Among others, it is significant of the fact that for some years now the members of that organisation have simply been aching for a leader having the necessary ability and audacity to suit the requirements of the present time. In Mr. Tom Mann a very large majority of the members believe they have found the individual they require. That he is possessed of organising ability and oratorical power goes without saying, and the members of the A.S.E. are hoping that under his leadership they will attain a position far superior to any they have yet attained. Some of the inspired journals of the political world are of the opinion that the Executive Council will keep him somewhat in restraint, but that idea only shows their ignorance of Mr. Tom Mann's character.

Another significant sign is the steady and vigorous support accorded to Mr. Robert Smillie by the members of the Miners' Federation of Great Britain. He is to-day the foremost man, so far as miners are concerned, and it is useless to try and minimise the effect of his work in connection with the late Sankey Commission. To the miners it is quite plain that as their representative on the Commission he made good, and in spite of a vigorous Press campaign against him, he came out "top dog." Also the growing agitation amongst the miners for the raising of the Income Tax limit is a very real one, and will be pursued until one of two things happens. The cost of living will have to be reduced, or the figure at which wages can be taxed will have to be raised materially.

The Indicator.

But a greater sign than the foregoing is to be found in the results of the recent municipal elections: and these are well worthy of a careful study by all interested in the work of economic and social progress. In connection with the astounding election results throughout the country, there are one or two strikingly significant phases.

As everyone knows, for some months past there has been a vigorous campaign carried on amongst the industrial workers of the community, in favour of what is called "direct action," and it has to be admitted that the policy obtained a very large number of adherents. Yet, in face of this fact, it is nevertheless true that in those places where "direct action" was most popular, the labour victories have been most remarkable. This goes to show, that while prepared to accept the policy of "direct action," the workers of this country are not prepared to let slip any opportunity to better their condition when constitutional means are available.

The vacillating policy of the Government has caused the workers to bethink themselves, and they are beginning to feel that they were "sold" at the last General Election. None of the promises of the politicians have been fulfilled. Those homes fit for heroes are not yet forthcoming. C3 citizens are still being manufactured. Profiteering in necessary commodities goes on unblushingly. Waste and extravagance is still the order of the day in Government Departments. Germany has not been made to pay for the war, and the Kaiser is still unhung.

On the other hand, unemployment is on the increase, winter is upon us, and unless something is done to avert it, there will be serious trouble in the early future.

The new demands of the Calder Valley ironfounders and coremakers goes to prove that they are not going to be content with specious promises, but that they are out for tangible improvement in their living conditions.

The demand of the Scottish shipbuilding trades for a minimum wage of 2s. 2d. per hour is further evidence of the same feeling.

The growing discontent prevalent amongst the lower middle class does not tend towards the bringing about of industrial harmony, and the organisation of the Middle Class Union is the outcome of the growing discontent.

The so-called professional politicans are hopeless for saving the situation, and the great bulk of the community have neither faith nor trust in the present Government.

Now is the time for those really interested in saving the commercial and industrial supremacy to get to work, and that quickly. Every hour of delay increases the danger, and the time to act is now.

The engineering industry is the most important of all industries, particularly in an age when in every direction mechanical means are displacing manual force.

Does this great industry foster a Napoleon? If so, now is the time for him to appear. What is wanted is a lead, and with a real leader, and a righteous cause, followers in abundance will not be wanting.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

(Continued from page 86.)

Fig. 71 shows a sectional drawing of Marshall's trip gear. The gear consists of equilibrium double-beat steam valves A and exhaust valves N, one of each for each end of the cylinder, with suitable operating mechanism driven from the lay shaft M, which is geared to the engine crankshaft by mitre wheels with machine-cut teeth.

The steam admission valves are lifted alternately by levers B, which are depressed at their outer end by the bell-crank levers C. Motion is given to the bell cranks by eccentrics E, which reciprocate the side links D carrying the bell cranks on pivots. A stop is provided so that the bell crank, which is counter-weighted by its inner arm, occupies the correct position for engaging with the lifting lever B.

The amount of the engagement is constant, and the period of engagement is determined by the governor, which is connected to the shaft J. This shaft carries the eccentrics H, which vary the position of the trip pads G.

The travel of the eccentric E brings the inner arms F of the bell-crank levers C into contact with the trip pads G, and the further movement compels disengagement between lifting levers B and bell cranks C.

Weights of Lengths of Rolled Steel Sections.

Beam 12 in. × 6 in. × 53 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 2 26	9 1 24	14 0 22	0 18 3 20	1 3 2 18	1 8 1 16	1 13 0 14	1 17 3 12	2 2 2 10	0
1	0 1 25	5 0 23	9 3 21	14 2 19	0 19 1 17	1 4 0 15	1 8 3 13	1 13 2 11	1 18 1 9	2 3 0 7	1
2	0 3 22	5 2 20	10 1 18	15 0 16	0 19 3 14	1 4 2 12	1 9 1 10	1 14 0 8	1 18 3 6	2 3 2 4	2
3	1 1 19	6 0 17	10 3 15	15 2 13	1 0 1 11	1 5 0 9	1 9 3 7	1 14 2 5	1 19 1 3	2 4 0 1	3
4	1 3 16	6 2 14	11 1 12	16 0 10	1 0 3 8	1 5 2 6	1 10 1 14	1 15 0 2	1 19 3 0	2 4 1 26	4
5	2 1 13	7 0 11	11 3 9	16 2 7	1 1 1 5	1 6 0 3	1 10 3 1	1 15 1 27	2 0 0 25	2 4 3 23	5
6	2 3 10	7 2 8	12 1 6	17 0 4	1 1 3 2	1 6 2 0	1 11 0 26	1 15 3 24	2 0 2 22	2 5 1 20	6
7	3 1 7	8 0 5	12 3 3	17 2 1	1 2 0 27	1 6 3 25	1 11 2 23	1 16 1 21	2 1 0 19	2 5 3 17	7
8	3 3 4	8 2 2	13 1 0	17 3 26	1 2 2 24	1 7 1 22	1 12 0 20	1 16 3 18	2 1 2 16	2 6 1 14	8
9	4 1 1	8 3 27	13 2 25	18 1 23	1 3 0 21	1 7 3 19	1 12 2 17	1 17 1 15	2 2 0 13	2 6 3 11	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 4·41	0 8·83	0 13·25	0 17·66	0 22·08	0 26·50	1 2·91	1 7·33	1 11·75	1 16·17	1 20·58	1 25	

Weights of Lengths of Rolled Steel Sections.

Beam 12 in. × 6 in. × 53 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 7 1 8	4 14 2 16	7 1 3 24	9 9 1 4	11 16 2 12	14 3 3 20	16 11 1 0	18 18 2 8	21 5 3 16	0
10	0 4 2 26	2 12 0 6	4 19 1 14	7 6 2 22	9 14 0 2	12 1 1 10	14 8 2 18	16 15 3 26	19 3 1 6	21 10 2 14	10
20	0 9 1 24	2 16 3 4	5 4 0 12	7 11 1 20	9 18 3 0	12 6 0 8	14 13 1 16	17 0 2 24	19 8 0 4	21 15 1 12	20
30	0 14 0 22	3 1 2 2	5 8 3 10	7 16 0 18	10 3 1 26	12 10 3 6	14 18 0 14	17 5 1 22	19 12 3 2	22 0 0 10	30
40	0 18 3 20	3 6 1 0	5 13 2 8	8 0 3 16	10 8 0 24	12 15 2 4	15 2 3 12	17 10 0 20	19 17 2 0	22 4 3 8	40
50	1 3 2 18	3 10 3 26	5 18 1 6	8 5 2 14	10 12 3 22	13 0 1 2	15 7 2 10	17 14 3 18	20 2 0 26	22 9 2 6	50
60	1 8 1 16	3 15 2 24	6 3 0 4	8 10 1 12	10 17 2 20	13 5 0 0	15 12 1 8	17 19 2 16	20 6 3 24	22 14 1 4	60
70	1 13 0 14	4 0 1 22	6 7 3 2	8 15 0 10	11 2 1 18	13 9 2 26	15 17 0 6	18 4 1 14	20 11 2 22	22 19 0 2	70
80	1 17 3 12	4 5 0 20	6 12 2 0	8 19 3 8	11 7 0 16	13 14 1 24	16 1 3 4	18 9 0 12	20 16 1 20	23 3 3 0	80
90	2 2 2 10	4 9 3 18	6 17 0 26	9 4 2 6	11 11 3 14	13 19 0 22	16 6 2 2	18 13 3 10	21 1 0 18	23 8 1 26	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	23 13 0 24	47 6 1 20	70 19 2 16	94 12 3 12	118 6 0 8	141 19 1 4	165 12 2 0	189 5 2 24	212 18 3 20	236 12 0 16	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 52 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 2 16	9 1 4	13 3 20	0 18 2 8	1 3 0 24	1 7 3 12	1 12 2 0	1 17 0 16	2 1 3 4	0
1	0 1 24	5 0 12	9 3 0	14 1 16	0 19 0 4	1 3 2 20	1 8 1 8	1 12 3 24	1 17 2 12	2 2 1 0	1
2	0 3 20	5 2 8	10 0 24	14 3 12	0 19 2 0	1 4 0 16	1 8 3 4	1 13 1 20	1 18 0 8	2 2 2 24	2
3	1 1 16	6 0 4	10 2 20	15 1 8	0 19 3 24	1 4 2 12	1 9 1 0	1 13 3 16	1 18 2 4	2 3 0 20	3
4	1 3 12	6 2 0	11 0 16	15 3 4	1 0 1 20	1 5 0 8	1 9 2 24	1 14 1 12	1 19 0 0	2 3 2 16	4
5	2 1 8	6 3 24	11 2 12	16 1 0	1 0 3 16	1 5 2 4	1 10 0 20	1 14 3 8	1 19 1 24	2 4 0 12	5
6	2 3 4	7 1 20	12 0 8	16 2 24	1 1 1 12	1 6 0 0	1 10 2 16	1 15 1 4	1 19 3 20	2 4 2 8	6
7	3 1 0	7 3 16	12 2 4	17 0 20	1 1 3 8	1 6 1 24	1 11 0 12	1 15 3 0	2 0 1 16	2 5 0 4	7
8	3 2 24	8 1 12	13 0 0	17 2 16	1 2 1 4	1 6 3 20	1 11 2 8	1 16 0 24	2 0 3 12	2 5 2 0	8
9	4 0 20	8 3 8	13 1 24	18 0 12	1 2 3 0	1 7 1 16	1 12 0 4	1 16 2 20	2 1 1 8	2 5 3 24	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	4·34	8·68	13·02	17·36	21·70	26·04	1 2·38	1 6·72	1 11·06	1 15·4	1 19·74	1·24	

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 52 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 6 1 20	4 12 3 12	6 19 1 4	9 5 2 24	11 12 0 16	13 18 2 8	16 5 0 0	18 11 1 20	20 17 3 12	0
10	0 4 2 16	2 11 0 8	4 17 2 0	7 3 3 20	9 10 1 12	11 16 3 4	14 3 0 24	16 9 2 16	18 16 0 8	21 2 2 0	10
20	0 9 1 4	2 15 2 24	5 2 0 16	7 8 2 8	9 15 0 0	12 1 1 20	14 7 3 12	16 14 1 4	19 0 2 24	21 7 0 16	20
30	0 13 3 20	3 0 1 12	5 6 3 4	7 13 0 24	9 19 2 16	12 6 0 8	14 12 2 0	16 18 3 20	19 5 1 12	21 11 3 4	30
40	0 18 2 8	3 5 0 0	5 11 1 20	7 17 3 12	10 4 1 4	12 10 2 24	14 17 0 16	17 3 2 8	19 10 0 0	21 16 1 20	40
50	1 3 0 24	3 9 2 16	5 16 0 8	8 2 2 0	10 8 3 20	12 15 1 12	15 1 3 4	17 8 0 24	19 14 2 16	22 1 0 8	50
60	1 7 3 12	3 14 1 4	6 0 2 24	8 7 0 16	10 13 2 8	13 0 0 0	15 6 1 20	17 12 3 12	19 19 1 4	22 5 2 24	60
70	1 12 2 0	3 18 3 20	6 5 1 12	8 11 3 4	10 18 0 24	13 4 2 16	15 11 0 8	17 17 2 0	20 3 3 20	22 10 1 12	70
80	1 17 0 16	4 3 2 8	6 10 0 0	8 16 1 20	11 2 3 12	13 9 1 4	15 15 2 24	18 2 0 16	20 8 2 8	22 15 0 0	80
90	2 1 3 4	4 8 0 24	6 14 2 16	9 1 0 8	11 7 2 0	13 13 3 20	16 0 1 12	18 6 3 4	20 13 0 24	22 19 2 16	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	23 4 1 4	46 8 2 8	69 12 3 12	92 17 0 16	116 1 1 20	139 5 2 24	162 10 0 0	185 14 1 4	208 18 2 8	232 2 3 12	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

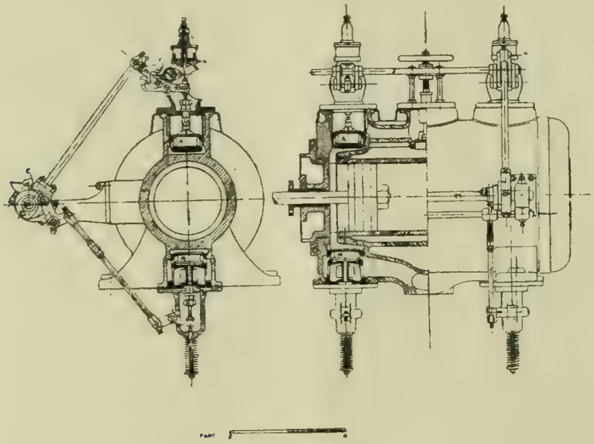
It will be noticed that the pressure of F on the trip pad G has little or no tendency to rotate shaft J. The work of disengaging does not thereby react on the governor, which in consequence runs with marked steadiness.

Immediately disengagement is complete, the valves close smartly and quickly under the influence of the helical springs and the air cushion in the spring boxes L.

The air valves K regulate the actual closing speed, and prevent undue pounding and wear between the valves and seats.

The exhaust valves are operated by cams as shown.

Table 14 gives dimensions of trip gear for a compound engine $14\frac{1}{2}$ in. × 25 in. × 36 in., 110 revolu-



GOVERNORS.—FIG. 71.

tions per minute. For other particulars see Fig. 71, which is to scale.

Calculations for Controlling Force.

Diameter of governor ball = 4in. Weight of one ball = 8.726 lb.

Radius to centre of ball at mid-position = $6\frac{1}{2}$ in. = .541 feet.

Centrifugal force of one ball at mid-position and 184 revolutions per minute = $8.726 \times .541 \times 184 \times 184 \times .00034 = 54.4$ lb.

Centrifugal force of two balls = 108.8 lb.

Controlling force at centre of balls = $.02 \times 108.8 = 2.176$ lb.

Radius to centre balls out-position = $7\frac{1}{8}$ in.; ditto in-position = $5\,{}^{15}/_{16}$ in.

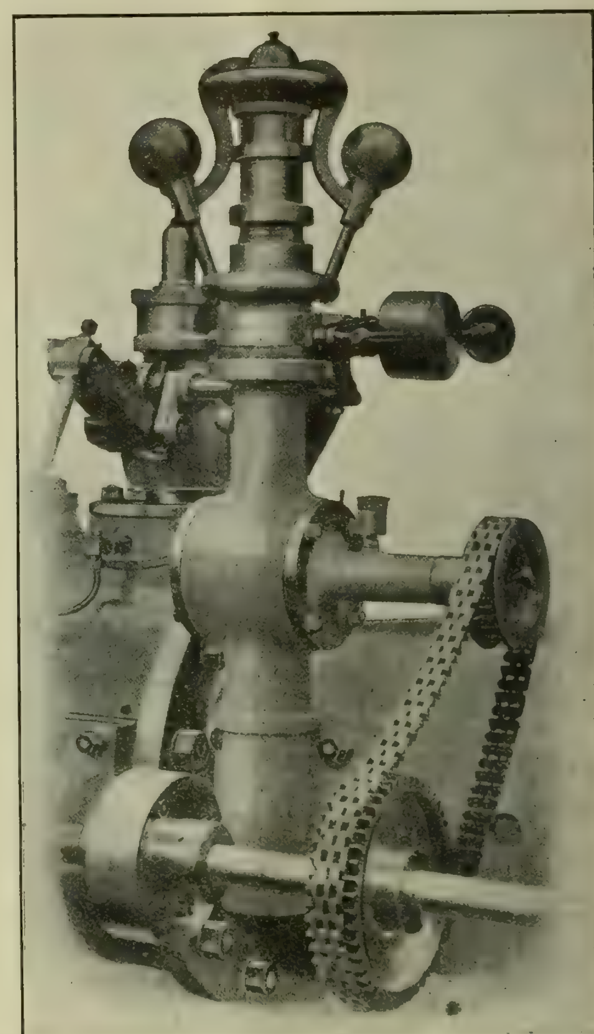
Movement of governor balls horizontally = $7\frac{1}{8} - 5\,{}^{15}/_{16} = 1\,{}^{3}/_{16}$ in.

Lift of governor = $1\frac{1}{4}$ in.

Controlling force at sleeve = $\dfrac{2.176 \times 1.1875}{1.25} = 2.06$ lb.

Twisting moment on trip spindle = $2.06 \times 5 = 10.3$ in. lb.

The governor is shown in Fig. 72. It is capable of



GOVERNORS.—FIG. 72.

controlling the speed of the engine from no load to $\frac{5}{8}$ in. cut-off with a speed variation of not more than four per cent.

Three sizes of governor are used with a series of engines from 7in. and 13in. diameter cylinders × 20in.

TABLE 14.

Working Pressure.	Diameter H.P. Cylinder.	Diameter Steam Valve.	Working Lift of Valve.	Valve Spindle Diameter	Trip Catch. Width	Trip Catch. Catch Clearance	Governor. Lift.	Governor. R.P.M.	Governor. Controlling Force at Sleeve.	Governor. Twisting Moment on Trip Spindle.	Chain Wheels for Governor Drive.
Lbs. per sq. inch.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.		Lbs.	Inch lbs.	
150	$14\frac{1}{2}$	$5\frac{1}{2}$		$\frac{5}{8}$	$1\frac{3}{4}$	$\frac{1}{8}$	$1\frac{1}{4}$	184	2	10·3	27 & 45 teeth $\frac{1}{4}$ in. pitch $1\frac{5}{8}$ in. wide

stroke, 135 R.P.M., to 22 in. and 38 in. diameter cylinders × 48 in. stroke, 75 R.P.M.

Size of Governor.	Governor Speed, r.p.m.	Lift, inches.	Controlling Force at Sleeve, lb.
No. 1.	265	$\frac{3}{4}$	1.18
No. 2.	184	$1\frac{1}{4}$	2.06
No. 3.	168	$1\frac{3}{8}$	4.55

Part III.

Governing of Internal-combustion Engines.

There are three methods of governing internal-combustion engines. They are referred to generally as:—(*a*) Hit or Miss; (*b*) Quality Governing; (*c*) Quantity Governing. Combinations of (*a*) and (*b*) and (*a*) and (*c*) are also used.

Hit or Miss.

This is generally used on the smaller sizes of gas engines, say up to 60 B.H.P. When the engine speed exceeds the normal, the working charge is completely cut out, so that no working stroke occurs until the speed again falls to its normal value. Thus, the number of working strokes is proportional to the load, and the quality and quantity of each working charge is always the same. Consequently, the fuel consumption will be as economical on light loads as on full load. This system has the disadvantage of large fluctations of speed on varying loads. By using heavy flywheels these cyclic fluctuations may be damped down. Inequality of working impulses also cause severe stresses in the engine parts.

Quality Governing.

In this case the governing mechanism reduces the proportion of gas, or fuel, to air, leaving the mass of charge per working stroke unaltered. As the engine load is reduced the mixture supplied becomes progressively weaker, whilst the compression remains unchanged. Hence the efficiency should be nearly as good at light loads as on heavy loads. In the earlier practice it was found that the weak mixtures produced at light loads were difficult to ignite, and combustion was very slow, in some cases continuing to the end of the exhaust stroke, thus igniting the next incoming charge.

By delaying the opening of the fuel valve until part of the suction stroke has been traversed, thus giving a richer mixture than the average near the sparking plugs, the difficulties of tardy ignition and slow combustion have been largely overcome.

Generally speaking, this method of governing is more suitable for cases where load and speed variation are small.

(To be continued.)

Standardisation of Chains.—The Association of British Driving Chain Manufacturers has now completed the standardisation of roller chains and wheel tooth forms. The Association standard chains of 1 in. pitch and upwards, as used for automobile and general engineering transmissions, will be available during 1920. Full details of the complete standardisation of roller chains are now published in pamphlet form, applications for which may be made to the Secretary, Association of British Driving Chain Manufacturers, Bassishaw House, Basinghall Street, London, E.C.2, or the following members: Brampton Brothers Ltd., Birmingham, "The Coventry" Chain Co. Ltd., Coventry, Hans Renold Ltd., Manchester, cycle and motor cycle, heavy roller and inverted tooth section; Alfred Appleby Chain Co. Ltd., Birmingham, Perry and Co. Ltd., Birmingham, cycle and motor cycle section.

A NATIONAL POLICY OF COAL CONSERVATION.

(Continued from page 95.)

In my own laboratory we have been during the past seven years continuously engaged in investigating lignites from all parts of the world, including Italy, Australia, Canada, and the Malay Peninsula, chiefly with regard to their low-temperature distillation and the cognate problem of converting them, by the action of heat at a moderate temperature, into fairly good steam coals, a process which opens up considerable economic and commercial prospects. I want you to realise, however, that although to us in Great Britain lignites may seem to be an unimportant class, yet, from the point of view of world-economics, they are probably destined in the near future to play a vastly greater part than they have done hitherto, both in regard to low-temperature distillation and for power purposes.

The bituminous group of coals, of which there are many sub-divisions, constitute the greater, and by far the most important, part of the world's total reserves. Those yielding, say, betwen 18 and 32 per cent of volatile matter (when carbonised at 1,000 deg. Cen.) are chiefly used for the manufacture of hard metallurgical coke; next come the "gas coals" (volatiles = 32 to 40 per cent), which yield a weaker coke but a larger volume of gas than the "coking coals" proper; finally, there is a class of non-coking "long-flame" coals (volatiles = 40 to 45 per cent), which used to be employed extensively for reverberatory furnace work. "Steam coals," of varying volatile contents, are also found in this great group. Next in order comes the semi-bituminous or anthracitic group of non-caking coals, volatiles = 8 to 20 per cent) which constitute the finest of all steam-raising coals, being smokeless (or nearly so) in their combustion; the famous South Wales Admiralty steam coals belong to this group. Finally, we have the anthracites proper (volatiles less than 8 per cent), which are chiefly used for domestic heating in closed stoves, for the firing of malting kilns and the like.

There are one or two outstanding points in connection with such classification to which I would direct your attention for a moment. First of all, what is termed the "coking properties" of coal seem to depend very largely upon the amount of "volatiles" which it yields on carbonisation at, say, 900 to 1,000 deg. Cen. Practically, all coals yielding less than 15 or more than 40 per cent of "volatiles" are non-coking; the coking properties suddenly (as it were) appear when the "volatile yield" reaches a point somewhere between 15 and 18 per cent, and are at their maximum when it is between 18 and 30 per cent. Beyond this limit the coking properties fall off rather rapidly, and finally disappear altogether when the "volatile yield" exceeds 40 per cent, and sometimes even below that limit. But whilst the coking properties may thus be connected empirically with the "volatile yield," we do not yet really understand their cause, and still less can we tell why they seem to arise so suddenly when a "volatile yield" reaches a point somewhat above 15 per cent, and then attain so rapidly their maximum degree. This is a matter upon which further research is greatly needed.

Again, within each of such groups and classes it is necessary, from an economic standpoint, to grade coals according to their ash contents. Only such coals as contain less than a certain proportion of ash can be regarded as "high-grade"; and when the ash-content is unduly high, then, although its "coal substance" may have the right properties, it is rendered unsuitable for coking or gas-making purposes. In many such cases, coal washing may be successfully resorted to as a means of eliminating a large proportion of the excessive mineral matter, but there are also cases where such separation would not pay.

Finally, there remains another important consideration to which I must, at this point, refer. Sometimes bituminous coals are encountered which are so soft in texture that, when they are removed from the seam, they have very little marketable value, although they may be very good coals for distillation purposes. These coals, if they are to be used at all profitably, must be consumed in the neighbourhood of the colliery. Otherwise, their value at any great distance away is small, inasmuch as they will not stand transport. So we have to solve the problem of dealing with coals which, although they may be very suitable for certain commercial purposes, are nevertheless of too soft or friable a nature for transport.

The Need of a "Free Trade" National Coal Research Policy.

It will thus be realised how many complex factors, arising out of the nature of the coals themselves, must be taken of in framing a national coal policy. Also, there are many fundamental problems connected with the chemistry of coal itself that must be attacked before such a policy can rest on a really scientific basis. This is why I so strongly advocated, both in my Presidential address to the Chemical Section of the British Association at Manchester in 1915, and also in my lectures before the Royal Institution in the following year, the undertaking, with the aid of public funds, of a "systematic chemical survey" of our British coalfields. And I accepted service with the Fuel Research Board in 1917 in the hope that such a survey would be inaugurated by it on broad and adequate lines.

Unfortunately, however, I soon realised that my hopes were not likely to be fulfilled. And here I feel it my duty to say that, in my opinion, the problem is such as will require the co-operation of all the best available minds and resources in the country, and that it will never be solved by bureaucratic methods or by any over-centralised policy which (whatever its intent) would, in effect, tend towards creating a monopoly of research on stereotyped lines. In the national interests, I have always advocated a policy of "free trade" in coal research, because I feel that the most vital requirement is a broadly-planned policy which will aim at stimulating and assisting experimental work on the chemistry of coal, fuel economy, and cognate subjects everywhere throughout the whole Kingdom; and I am opposed to anything which would tend to sterilise fuel research, or develop it along too exclusive lines. I trust that chemists and the public generally will see to it that a more enlightened policy prevails in the future.

Fortunately, our British available coal reserves, though quantitatively small, are for the most part qualitatively of the best, and, moreover, they are well situated both in regard to our ports and our iron-ore deposits. Also, they are unusually well varied in their qualities. Thus, in Durham we have perhaps the finest "coking" coal seams in the world; in Yorkshire and Derbyshire some of the best "gas coals"; in South Staffordshire good "furnace coals"; while the South Wales semi-bituminous steam coals are famous throughout the whole world. It seems as though Providence has put down in this little island of ours a great variety of materials, and that we are intended as a race to discover, invent, and pioneer things. This is one reason why this country has been so favourably situated for pioneering new industries. We have within our borders a great variety of raw materials, and this applies particularly to coal.

Having regard to the nature and variety of our available coals, and the paramount importance of our coal-export trade, it seems to me that the policy along which the commercial development of our coalfields ought to proceed should aim at (*a*) retaining for our own use the best "coking" and "gas" coals, but (*b*) in regard to "steam coals," to export the best grades and to generate the power required for our home industries, as far as possible, from low-grade coals. This is one reason why I have supported the idea of co-operative electric power-supply from large central stations, because it affords perhaps the best means of utilising our low-grade steam coals. This is likely to become a more pressing economic question as the development of our coal-fields proceeds.

The Proportion of the National Coal Output that Should be Carbonised.

Coal is so valuable a material that we ought as far as possible to avoid burning it in the raw state; but in our present state of industrial development it is difficult to realise this ideal. We ought always to aim at the recovery of valuable by-products. Certainly, the world's industrial development is already so far advanced that we can say that all coals intended for use in the smelting of iron and steel and in gas-making, and I hope in the near future also for domestic purposes consumption, should be carbonised in some way or other before use.

(*To be continued.*)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 88.*)

We now proceed to the study of spring leaves which are tapered in the plane of the thickness, and the first case is that of the:

No. 6 or Square-tapered Leaf Point.

This is the first case of tapering where the result is of real importance and has any considerable effect on the spring. The leaf is simply cut off square in the width, but it is tapered in the plane of the thickness. This point is shown on a larger scale in Fig. 22, on which are also given the symbols which

will be used in the analysis. In order to determine the deflections of leaves with the No. 6 point we have:

First: From $x = o$ to $x = l - c$.

For this portion of the leaf the cross section is uniform, and equations (22) to (24a) for the No. 1 point apply directly.

Second: From $x = l - c$ to $x = l$.

For this portion of the leaf it is readily seen that the moment of inertia is:

$$\mathrm{I} = \mathrm{I}_0 \frac{(l + d - x)^3}{(c + d)^3}$$

and therefore:

$$\frac{\mathrm{EI}_0}{\mathrm{W}} \frac{d^2y}{dx^2} = \frac{(c + d)^3 (l - x)}{(l + d - x)^3} \quad \ldots\ldots\ldots\ldots (40)$$

$$\frac{\mathrm{EI}_0}{\mathrm{W}} \frac{dy}{dx} = (c+d)^3 \left\{ \frac{-d}{2(l+d-x)^2} + \frac{1}{(l+d-x)} \right\} + \mathrm{C}_1 \quad \ldots (41)$$

$$\frac{\mathrm{EI}_0}{\mathrm{W}} y = (c + d)^3 \left\{ \frac{-d}{2(l + d - x)} - \log (l + d - x) \right\} + \mathrm{C}_1 x + \mathrm{C}_2 \quad \ldots\ldots\ldots\ldots (42)$$

where:

$$\mathrm{C}_1 = \frac{1}{2} (l^2 - 3c^2 - 3cd - d^2) \ldots\ldots\ldots (43)$$

$$\mathrm{C}_2 = \frac{1}{6} \Big\{ - l^3 + 3l (3c^2 + 3cd + d^2) - 2c^2 (4c + 3d) + 3d^2 (c + d) + 6 (c + d)^3 \log (c + d) \Big\} \quad \ldots (44)$$

At the end of the leaf, where $x = l$, equations (41) and (42) reduce to:

$$\frac{\mathrm{EI}_0}{\mathrm{W}} \frac{dy}{dx} = \frac{(c + d)^3}{2d} + \mathrm{C}_1 \quad \ldots\ldots\ldots\ldots (41a)$$

$$\frac{\mathrm{EI}}{\mathrm{W}} y = (c + d)^3 \left(-\frac{1}{2} - \log d \right) + \mathrm{C}_1 l + \mathrm{C}_2 \ldots (42a)$$

The logarithms are, of course, natural or hypobolic.

These equations (40) to (42a) may be said to be the most important of all in the theory of leaf

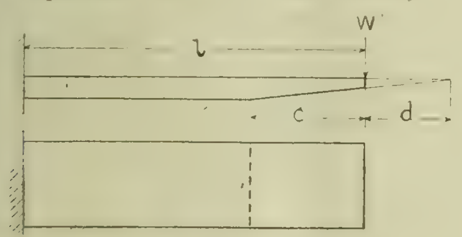


PLATE SPRINGS. FIG. 22.

springs. Unfortunately, they are somewhat complex, but still there is no real difficulty in applying them to practical cases, as will be shown shortly. The work is admittedly tedious, but that is all, and the results are of such great importance that the mere labour of arithmetical computation becomes a minor consideration. For regular commercial work, tables can be—and have been—calculated which greatly reduce the work, and with the aid of these tables it does not take long (considering the value of the results) to work out completely any given spring.

It has already been shown that a taper in the width only has scarcely any effect on a spring. A taper in the thickness, on the other hand, has an enormous effect, as will shortly be shown by the application of the above equations for the No. 6 point. A combination of the two tapers—in the width and in the thickness—is sometimes of much importance, but in general the effect of the taper in the width is very much less than that of the taper in the thickness. The equations for the leaf point No. 6 may be said to be of fundamental importance as regards the application of the new theory of leaf springs to practical springs.

The No. 6 leaf point is of such great importance that we here give an example taken from practice instead of an academic case of a spring with only two or three leaves. This spring, which was used on

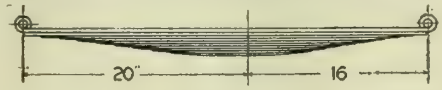


PLATE SPRINGS.—FIG. 23.

one of the American automobiles, is shown in Fig. 23, and the details of the tapering are shown in Fig. 24. The details of the shorter (16 in.) end, so far as required for present purposes, are given in the following table:

DETAILS OF THE SPRING SHOWN IN FIG. 23.

n	l_n	I_n	Z_n
1	5.6	.001225	.01197
2	6.9	.001215	.01197
3	8.2	.001215	.01197
4	9.5	.001215	.01197
5	10.8	.001215	.01197
6	12.1	.001215	.01197
7	13.4	.001557	.01415
8	14.7	.001982	.01665
9	16.0	.002566	.01982
10	16.0	.004013	02675

Plate No. 9 (the long plate) is not tapered, and for the purpose of calculating the reactions, plates Nos. 9 and 10 must be taken together and considered as one plate, with a moment of inertia equal to the sum of the moments of inertia of each—that is (.002566 + .004013) = .006579.

It will be noticed that the overhangs, after the first, are all 1.3 in. and that the tapers at the ends of the leaves are $c = d = 4$ in. There are then only two cases to which we have to apply the taper equations: first, for the case where we are dealing with the

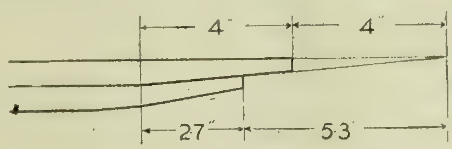


PLATE SPRINGS.—FIG. 24.

reactions on the end of a leaf, when $c = d = 4$; and, second, when we are dealing with the reaction on a leaf from the "plate below," in which case the reaction acts at a distance of 1.3 in. from the end of the leaf, so that we have $c = 2.7$ in. and $d = 5.3$ in.; as is indicated in Fig. 24.

A study of equations (40) to (42a) will show that they may be considerably reduced for the numerical work in the following manner when the tapers are the same:

First, for $c = d = 4$.

On inserting these values of c and d into equations (43), (44) and (42a) there results:

$$C_1 = \frac{1}{2}(l^2 - 112)$$

$$C_2 = \frac{1}{6}(-l^3 + 336l - 5876)$$

for $x = l$,

$$\frac{EI}{W} y = 965{\cdot}71 + C_1 l + C_3$$

Second, for $c = 2.7$, $d = 5.3$.

$$C_1 = \frac{1}{2}(l^2 - 92{\cdot}89)$$

$$C_2 = \frac{1}{6}(-l^3 + 278{\cdot}67\, l + 6672{\cdot}9)$$

for $x = l$,

$$\frac{EI}{W}\frac{dy}{dx} = 48{\cdot}202 + C_1$$

$$\frac{EI}{W} y = -1109{\cdot}86 + C_1 l + C_2$$

Using these reduced expressions, the values of the various C's are readily calculated on inserting the various values of the l's; they will be found to be as follows:

	$c = d = 4$		$c = 2{\cdot}7,\ d = 5{\cdot}3$	
n	C_1	C_2	C_1	C_2
1	−40.320	1263.7	−30.765	1342.9
2	−32.195	1311.0	−22.640	1377.8
3	−22.380	1346.6	−12.825	1401.0
4	−10.875	1368.4	− 1.320	1410.4
5	2.320	1374.2	11.875	1403.7
6	17.205	1361.7	26.760	1378.7
7	33.780	1328.7	43.335	1333.3
8	52.045	1273.1		

(*To be continued.*)

NOTES, RULES, AND CALCULATIONS RELATING TO BELTING.

By F. R. Parsons.

The following rules and values relating to the various problems encountered in the transmission of power by belting are taken from the writer's note book, collected and tabulated during several years practical association with the subject. At the moment their sources cannot be recorded, but many of them are the outcome of personal experience, worked out from actual results.

Belt Speed and Power.

One horse power will safely be transmitted by a single belt 1 in. wide, running at 900 feet per minute.

Every 0.2 square inch of belt section will, at a speed of 1,000 feet per minute, transmit 1 h.p.

One foot per minute of belt speed per inch of width will transmit 1 watt of electrical energy. Therefore, if belt speed in feet per minute be multiplied by width in inches, the result will be total energy delivered in watts. Divided by 1,000 the results will be kilowatts. This rule holds good for single belting, if light double belting from 30 to 35 per cent additional energy may be expected. From this rule we may obtain width of belt required, as follows:

$$W = \frac{\text{Amps} \times \text{Volts}}{\text{Velocity}} = \frac{\text{Watts}}{V}$$

Rules for Roughly Calculating H.P. of Single and Double Belts.

Multiply width of belt in inches by 45 for single, by 75 for double belts, multiply this again by velocity in feet per minute, and divide by 33,000 = horse power transmitted. Or reverse example:—

$$\frac{\text{Horse Power} \times 33000}{45 \times \text{Velocity}} = \text{width of belt required.}$$

Another rule for ascertaining double leather belt width when actual horse power required to be transmitted is known, is:—

$$\frac{\text{A.H.P.} \times 7000}{\text{L.}} \div V = \text{width in inches.}$$

When A.H.P. = actual horse power; L = length of belting covering smallest pulley, in inches; V = speed of belt in feet per minute.

Because a leather belt usually runs thicker as its width is increased, the tension difference per inch of width would also correspondingly increase. Thus the writer has found that for belts over 6 in. in width, a more reliable calculation for ascertaining belt width is the following:—Multiply the horse power by 33,000, divide this by belt speed in feet, add 120, and divide by 76.

To Find the Arc of Contact of a Belt.

Divide five times the pulley difference in inches, by the centre distance in feet, and subtract from 180 deg.

To Ascertain the Length of an Open Belt.

Add the diameters of the two pulleys together, divide by 2, and multiply the quotient by $3\frac{1}{4}$. Then add this product to twice the distance between the centres of the respective shafts.

To Ascertain the Length of a Crossed Belt.

Mark off by laying lines to scale the pulleys, set at their proper distance apart, and measure the length of the side of the belt, supposing the belt to envelop one-half the circumference of each pulley. If there is a great difference of the relative diameters of the pulleys, and the distance between the shaft centres is short, the length of the straight sides of the belt should be measured, and the arcs of contact around the pulleys stepped around by compasses; the set of the latter being not more than about one-tenth the pulley circumference.

To Compute the Approximate Length of a Belt when Closely Coiled.

The sum of the diameter of the roll, and of the eye in inches multiplied by the number of coils made by the belt, and by 0.1309 = length in feet.

Belt Tension and Stretch.

The ultimate tenacity of good leather belting $\frac{7}{32}$ ins. thick is about 1,000 lbs. per inch of width, but allowing for joints, etc., the maximum tension to which it should be subjected should not exceed 80 lbs. for single leather, 140 to 150 lbs. for double belts twice the thickness.

A fair amount of total stretch in good leather belting would not exceed 7 per cent of its original length; 35 per cent of this being generally reached during the first six months of its use.

Coefficient of Friction.

The coefficient of friction between a belt and the pulley may be taken as 0.4. Therefore, if the arc of contact is 150 degrees, the power actually available is 52 lbs. and 96 lbs. respectively per inch of width for single and double belts; this neglecting stress, due to centrifugal force of belt velocity, is high.

To Ascertain Coefficient of Friction.

A simple experiment for the purpose of ascertaining the coefficient value of a belt, or piece of belting, can be conducted as follows:—Take a fairly smooth and bright pulley, say 12 to 15 in. diameter, and fix to a shaft well within reach of the floor, the shaft not being in motion. Place over the pulley the length of belting, allowing it to hang down at each end, say, two or three feet, and to each end of the belt suspend an equal weight or weights. The belt will now have an equal tension on each side. At one end add extra weight until the belt begins to slip on the pulley. If now the excess weight be divided by the total weight upon the belt at the point of slipping, we shall have as the quotient the value of the coefficient Say, for example, the equalising weights are 60 lbs. each, and the weight added to one side of the belt is 80 lbs., then coefficient is expressed thus:—

$$\frac{80}{80+60+60} = \frac{80}{200} = 0.4.$$

Driving Tension of a Belt.

The driving tension of a belt is the difference between the stress applied to its two sides when in motion. Thus, supposing we were to check the two different forces by means of a spring balance, and we found them to be, say, 30 lbs. on the slack side of the belt, and 70 lbs. on the driving side, expressed as T_1 and T_2 respectively. Then the difference, namely 40 lbs., would represent the driving tension of a belt. This, if multiplied by velocity, and divided by 33,000 will give the rate of doing work in horse power units. Expressed mathematically it would be:—

$$\frac{(T_2 - T_1) \times V}{33000} = \text{H.P.}$$

Coefficient may also be obtained when the driving tension is a known quantity, thus:—

$$T_2 - T_1 = 40\text{lbs., and } \frac{40}{30+70} = 0{\cdot}4.$$

When a spring balance is employed in conjunction with a belt clamp for jointing purposes, with the belt at rest, a tension of 70 lbs. per inch of width for a double leather belt should be recorded; this working out at about 240 lbs. per square inch section.

Centrifugal Force.

To calculate the stress on belting due to the action of centrifugal force:—

Let W = the weight of 1 cubic inch of leather, which equals, say, 0.0358 lbs; then:—

$$\text{Centrifugal Force} = \frac{0{\cdot}0358 \times V^2 \times 2 \times R \times 12}{G \times R \times 2}$$

$$= \frac{{\cdot}4296 \times V^2}{G}$$

Therefore applying this rule to a belt running at 5,000 feet per minute, the belt being ¼ in. thick, it will have a stress, due to centrifugal force, of 22.8 lbs. per inch of width.

BOILERS FOR HOT WATER AND HEATING PURPOSES.

Engineers responsible for the installation of boilers designed to supply hot water for heating and domestic purposes are much concerned with the deposit of "fur" or incrustation which inevitably forms in the pipes and heaters.

Where the hot water supply is large in volume, as is the case in big establishments, the difficulty is very serious, as it necessitates pulling pipes out for renewal or to free them mechanically from the deposit of scale-forming matter.

Many inquiries are received from firms in this line of trade by the British Boiler Fluid and Engineers' Stores Co. Ltd., the well-known manufacturers of "Dejecoline" boiler fluid.

This fluid is only suitable for boilers generating steam. It does not taint or contaminate "live" steam, and consequently is largely used by brewers, confectionery works, hospitals, and public institutions where the steam is used direct from the generating plant. There is, however, a great difference between a steam boiler and a hot water apparatus. One has, more or less, great pressure, and is intended, of course, to produce steam, and such boiler may be kept entirely free from scale by using a scale-removing fluid without any risk or trouble. A hot water apparatus has no pressure of any consequence, and is designed to heat the water used for baths, heating and domestic purposes. Obviously, any foreign matter introduced into these low-pressure boilers passes over with the water drawn off at a comparatively insignificant pressure, seldom exceeding boiling point, and no chemical disincrustants can be mixed with such water used for domestic purposes with safety to health.

The only solution of the difficulty lies with hot water engineers themselves to scrap the obsolete system which now prevails, and for them to devise boilers which will generate steam, and not merely serve the purpose of the domestic kettle on the scullery gas ring.

In America, heating and hot water supplies are not dependent upon an inaccessible dangerous contrivance buried behind a kitchen range. When one of those alleged boilers blow up, the consequences are serious. Why they do not more frequently explode is more providential than scientific. In many houses, hotels, and institutions hot water pipes are twisted and curved in the most ingenious manner, designed to trap all deposits from the hot water supply. The result is "choking" and obstructions, which only permit a minimum of hot water to pass through, and necessitating an enormous consumption of fuel to obtain "warm" water slightly over blood heat.

As stated, it is no use in these cases appealing to the manufacturers of "Dejecoline" boiler scale removing fluid. It can only be used in an ordinary steam boiler.

In such cases it is absolutely useless to apply a scale-removing fluid. It becomes obvious, then, that hot water supply engineers must adopt a different method in the construction and design of their installation system if they desire to avoid the present trouble and meet the requirements of their clients.

CAMS.

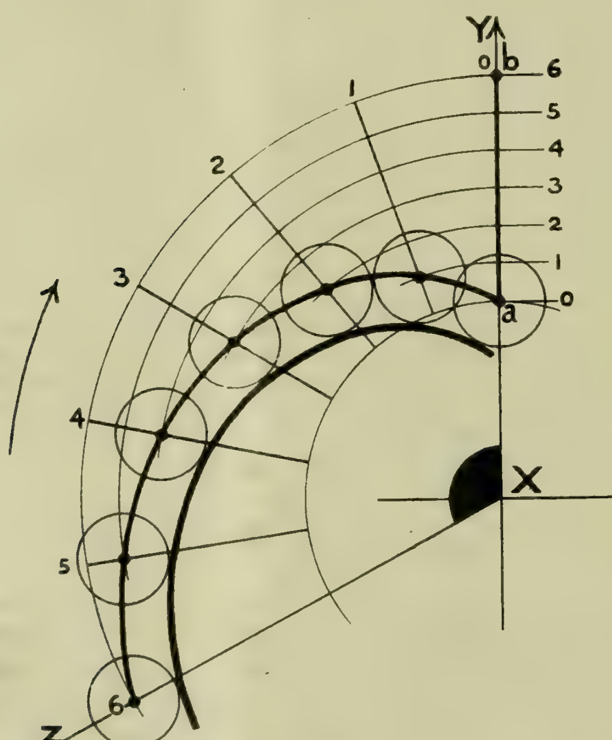
By W. E. Bennison, A.M.I.M.E.

(*Continued from page 75.*)

Various Examples.

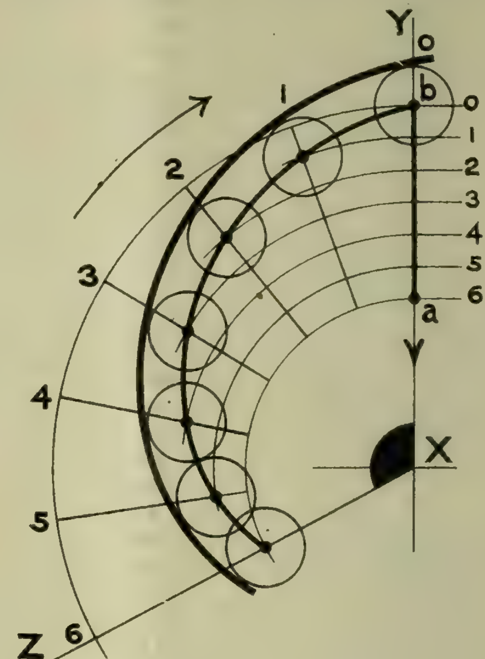
Examples will now be given showing how to lay out various spiral cam forms according to the principles enunciated.

I. Uniform velocity ; roller contact ; rectilinear motion, direction passing through axis.—Figs. 24 and 25 show the lay-out for these conditions : in Fig. 24 the direction of motion is away from the axis while in Fig. 25 it is towards the axis. The description and lettering applies to both figures. X is the cam axis, *a b* the follower path, and Z X Y the cam angle. While the cam revolves through the angle Z X Y the centre of the roller must be moved



Cams.—Fig. 24.

along the straight line from *a* to *b*. As the cam is rotating in a clockwise direction the line *a b* must be revolved round X in an anti-clockwise direction. The angle Z X Y is divided into any number of equal divisions and from the end of every division a radial line drawn. In the present example six divisions are taken : the radial lines, including the original line *a b* and numbered from 0 to 6, and they represent the various positions of the follower path. The line *a b* must now be divided into six parts, and the spacing of these is quite simple because the velocity is uniform. It is not necessary to draw a displacement curve, but one is given in Fig. 26 to show what form it takes. As the velocity is uniform the follower moves through equal spaces in equal times ; thus every part of the diagram is similar and the space-time curve is a straight line. To put it another way, the slope of the curve varies as the velocity, and as the velocity is uniform, the slope of the curve is constant ; the curve is therefore a straight line. As the ordinates are equally spaced their intersections with the straight line curve if projected horizontally into the line *a b* at the left of the diagram, will divide that line into equal spaces. To return to the cam diagrams (Figs. 24 and 25) the follower path *a b* must be divided into six equal parts, and the points thus obtained numbered 0 to 6.



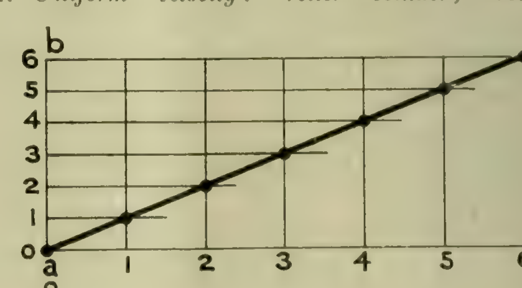
Cams.—Fig. 25.

If an arc is drawn through every point to cut the radial line of the same number the intersections give the centres of the roller. Circles of the roller diameter drawn about these centres show the roller in its various positions. The true cam curve is a curve drawn through the roller centres ; the actual cam curve is a curve drawn touching the circles. In Fig. 24 the actual cam curve is drawn inside the circles and in Fig. 25 it is outside the circles.

The true cam curve is the well-known Archimedian spiral.

In this particular case the cam angle is equal to the angle subtended by the cam curve.

II. Uniform velocity : roller contact ; rectilinear

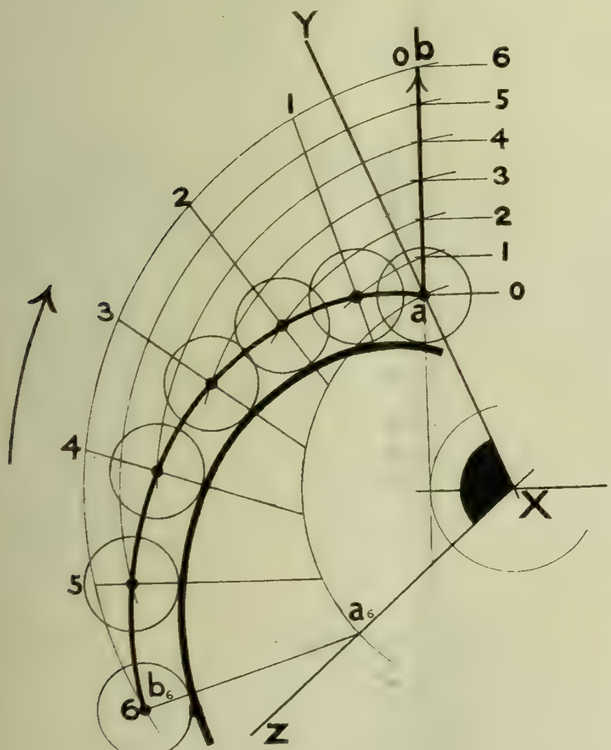


Cams.—Fig. 26.

motion, direction offset.—This case differs only from the previous one in that the direction of motion does not pass through the centre, and the construction is very similar. The lay out is shown in Fig. 27. Both the point *a* and the point *b* are swung through the angle Y X Z, the new positions being a_6 and b_6 : the line a_6 b_6 gives the final

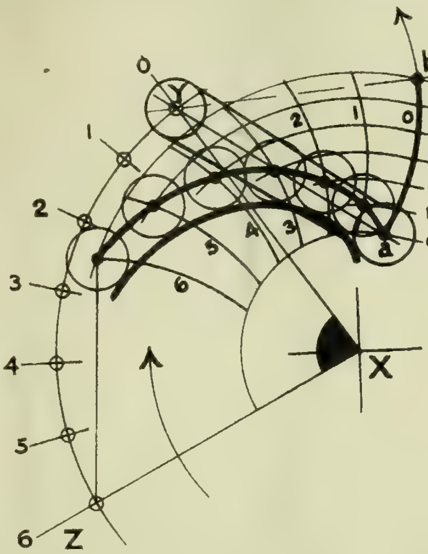
position of the follower path. If, say, the arc $b\,b_6$ be divided into any number of equal parts the intermediate positions of $a\,b$ are found. The lines will not be radial in this case, but if a circle be drawn about the point X touching $a\,b$ produced every position of $a\,b$ will be tangent to this circle. The rest of the construction is exactly similar to Fig. 24, the line $a\,b$ being divided into equal parts and the points turned into their respective follower path positions; the intersections give the various positions of the roller centre.

III. Uniform velocity: roller contact; angular motion. (See Fig. 28.).—The roller is mounted on the free end of a lever which is fulcrumed at the point Y; the centre of the roller will move along the circular arc $a\,b$, which is the follower path: X is the axis of the cam and Z X Y the cam angle. The direction of rotation of the cam is shown by an arrow and the arc $a\,b$ is revolved around X in the opposite direction to the arrow. To do this a number of positions for the lever fulcrum Y must first be determined. The point Y is rotated about X through the angle Y X Z which will bring it to the point Z: the arc Y Z is divided into any number of equal parts, and the points thus obtained represent the lever fulcrum in its various positions; in the present case six divisions are again taken and the fulcrum positions are numbered 0 to 6 from Y to Z. About each of these fulcrum points an arc is described of radius Y a (the length of the lever): these arcs represent the various positions of the follower path and are numbered 0 to 6 commencing with $a\,b$.



Cams.—Fig. 27.

Next the arc $a\,b$ must be divided into six equal spaces. The displacement curve will be the same as for rectilinear motion, viz (Fig. 26), only it must be borne in mind that the height of the diagram must be equal to the length of the arc $a\,b$ (not the chord), and each of the small divisions obtained from that diagram represents a small arc. In cases where the angular movement of the lever is small, and where the chord $a\,b$ passes through or near to the axis it may be near enough to divide the chord, but in many cases that is not permissible. The points obtained by equally dividing $a\,b$ are numbered 0 to 6, and through each point is drawn an arc carrying the same number as the point. The intersection of



Cams — Fig. 28.

each of these arcs with the follower path position of corresponding number gives a point on the true cam curve. The actual cam curve is drawn touching the roller circles described about these points as in the previous examples.

(To be continued.)

Trade Items, Notes, &c.

Water-power Resources in India.—By order of the Government of India a systematic investigation of the water-power resources of that country was made last winter. In a preliminary report it is stated that a round estimate of 1,774,000 electrical horse power in sight is vastly below the actual power which the final results of the survey will show. The following figures of known and probable sites where there is a reasonable prospect of obtaining power are given :—

Name of Province.	Continuous electrical horse power.
Assam	51,200
Bengal	203,600
Bihar and Orissa	12,800
Bombay	258,300
Burma	439,000
Central Provinces	153,000
Cochin	25,000
Kashmir	30,000
Madras	106,000
North-West Frontier Province	20,000
Punjab	260,900
United Provinces and Benares	32,200
Total	1,592,000

Coal-Handling Appliances.—There is an ever-increasing demand in all branches of industry for some form or another of labour-aiding and time-saving devices. As far as the boiler-house is concerned, a striking advantage is gained by the use of coal and ash-handling appliances. The Coventry Corporation have

installed this apparatus on a large scale in their electricity works, and apparently with great success. A new coal-receiving plant takes the place of the large elevator. The U-link wharf, or gathering conveyor, runs slightly below the ground-level, and a horizontal portion is so arranged as to coincide approximately with the length of the barges. The conveyor ascends at a moderate gradient to a sufficient height to feed by gravity into the revolving feeding device or filler of one of Messrs. Edward Benniss's gravity-bucket conveyors. The details of construction are given in a booklet recently issued by Messrs. Ed. Benniss and Co. Ltd., Little Hulton, Bolton.

The Institution of Automobile Engineers.—At the fourth meeting of the season of the above institution, held on December 3rd, 1919, a paper was read by Mr. Edgar M. Duffield, entitled "Car Design and Car Usage, from the Point of View of the Majority of Owner-Drivers." The paper provoked great interest, and a very keen discussion followed. An important step in connection with admission to the Institution has been taken by the Council. Every applicant for admission born on or since January 1st, 1890, whose qualifications are not sufficient to justify the Council in electing him a full member, will be required to satisfy the examiners in a written examination based on a syllabus which is ready for publication. This means that all those who seek election as associate members or graduates will have to have a certain standard of theoretical knowledge, as set forth in the syllabus, which will be issued to all applicants. There will be two examinations held per annum, so that applicants may have to wait three or four months before they are entitled to full admission. Admission to the meetings and other privileges will be accorded to those whose proposal forms are approved, subject to examination. The full details will be issued shortly. Graduates up to 30 years of age may be elected this year, up to 29 next year, and so on, until the original age limit of 26 is reached. This is done with a view to meeting the special conditions brought about by the war, whereby many men are undergoing training, when in ordinary circumstances they would be earning their living.

A New Submersible Salvage Pump.—There are few problems relative to pumping apparatus for ship's use that have received greater attention during the war than that of the possibility of keeping a ship afloat after she has been badly holed by mine or torpedo. It is obvious that if a compartment is badly damaged, no pumping apparatus would keep the water out. It is, however, quite within the range of possibility that the compartments adjacent to those damaged may be kept free from water, provided apparatus is ready for instant use in such an emergency. On several occasions, when a ship has been mined or torpedoed near shore, she could have been beached had it been possible to keep the water out of only slightly damaged compartments for a few hours. A pump which has been specially designed to meet the conditions indicated above is the Merryweather electrically driven submersible pump, with which a number of the White Star Line's ships have recently been equipped. The pump can be operated direct from the ordinary ship lighting set or from the emergency lighting set, where such is available, and can be used either totally submerged or above the water-level, the electric motor being carried in a hermetically sealed steel cylinder. A special feature of the apparatus is an intercepting chamber designed to prevent any possibility of water from the pump chambers finding access to the electric motor. A continuous working test, 48 hours' duration with the pump completely submerged, failed to show the slightest leakage of water into the motor cylinder. The pumps adopted by the White Star Line are capable of giving an output of over 60,000 gallons an hour.

"Correct Lubrication," a valuable little booklet to motorists, issued by the Vacuum Oil Company Ltd. It clearly explains the imperativeness of scientific lubrication, and emphasises the reward of this practice, economy of repairs, of depreciation and of fuel and oil. Most valuable remedies are given for engine and chassis troubles. A lengthy chart embracing most types of motors, passenger and commercial, British and imported, shows the exact grade of mobiloil to be used on each.

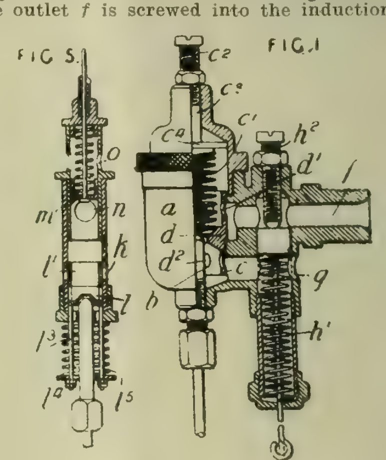
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

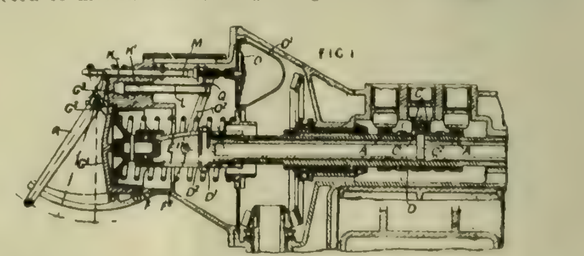
123,572.—A. D. Paterson, Moorgate Hall, Finsbury Pavement, London, and Oil Fuel Economiser Ltd., 14, Martin Place, Sydney, New South Wales, Australia.—Feb. 25th, 1918.—The mixing chamber *a* contains a fuel nozzle *b* and a floating choke member *c* which is controlled by engine suction and controls the air entering by an inlet *g* and the outlet of mixture through a conduit *f*; the greater the suction, the greater is the proportion of air to fuel. In the form shown, the member *c* has air inlet and mixture outlet apertures *d*2, *d*1 and a contraction *d* controlling the space around the fuel nozzle. It is acted on by a light spring *c*1 adjusted by means of a set-screw *c*2 acting on the stem *c*3 of a plate *c*4. The outlet *f* is screwed into the induction pipe and is



controlled by a piston valve *h* actuated by a Bowden wire or other means, the uppermost position of the valve being determined by an adjustable screw *h*2. At starting the valve *h* is used to close the air inlet *g*, so that fuel alone is supplied to the engine. The valve *h* in its lowest position allows air alone to pass direct from the inlet *g* to the outlet *f* to dilute the mixture from a second carburettor. In a modification, Fig. 5, the floating member *l* includes a sleeve *l*1 controlling secondary air inlets *k*1, and is connected by rods *l*3 to a plate *l*4 controlled by a spring *l*5. The plate *l*4 is held down by a trigger device at starting to enable fuel. In the form shown, the member *c* has air inlet and a piston valve *m*, which may be lowered to admit air alone from inlets *o* to the outlet *n*. The air supplies may be heated electrically or by exhaust gases, etc. The Provisional Specification states also that for heavy fuel an electric heating coil may be placed in or around the fuel nozzle or supply tube.

INTERNAL-COMBUSTION ENGINES.

123,585.—H. R. Ricardo, 21, Suffolk Street, Pall Mall, London.—Feb. 27th, 1918.—The inlet valves of an engine for aircraft, etc., are each actuated by an adjustable cam controlled by a barometric device which acts upon a valve for regulating the supply and delivery of a liquid to and from a chamber containing a piston connected to mechanism for adjusting the cam. Located between

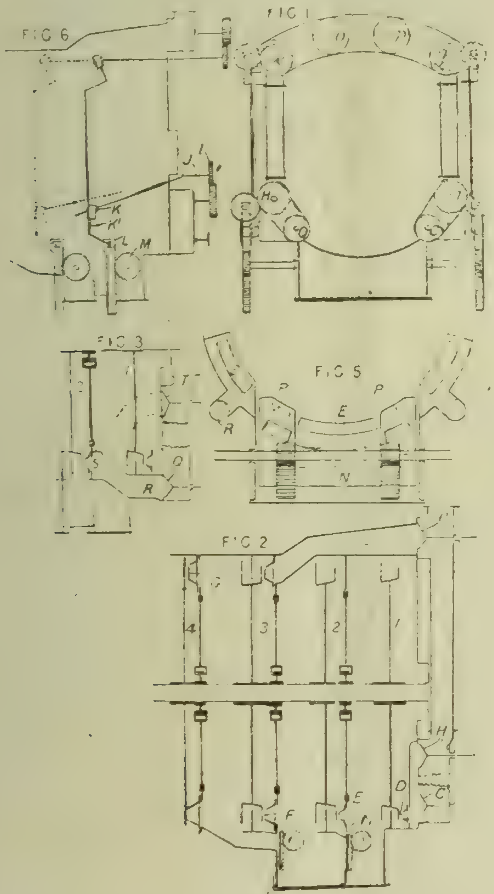


a pair of cams A for actuating exhaust valves is an inlet valve cam C, C1, the portion C1 of which may be adjusted angularly by a pin C2 carried on the shaft D. Rollers F2 are secured to the end of the shaft and work in helical grooves E1 formed in a sliding sleeve carried by a piston F which reciprocates in a cylinder G1 to which is supplied oil under pressure from a lubricating system. The cylinder G1 communicates through ports G2, G3 with a chamber K in which slides an open-ended valve L connected by a lever Q to a rod M secured to a movable

member O of a barometric device O1. The lever O is hinged at D2 to the piston and at its upper end it is adjustably connected to the rod M. A movement of the rod M in a left hand direction places an oil-supply port K1 in communication with the port G3 leading to the cylinder G1, admission of oil to which displaces the piston and so adjusts the cam as to reduce the period of opening of the inlet valve. This displacement of the piston alters the position of the fulcrum of the lever Q2, thus moving the valve and closing the ports G3. A movement of the rod M in an opposite direction opens the port G3 through which the oil from the cylinder is discharged into the interior of the valve. A manual actuation of the valve L may be effected by a hand lever R which can adjust the same to prolong but not reduce the opening of the inlet valve.

TURBINES.

123,624.—J. BROWN AND CO., and W. H. WOOD, Clydebank, Dumbartonshire.—March 25th, 1918.—Multi-stage turbines are provided with an arrangement of inter-stage valves and bye-passes adapted to minimise the variations in pressure drop over the respective stages under varying conditions of working, the nozzle area for passage of steam from a higher stage to the next succeeding lower stage being varied according to the supply of steam from the higher to the lower stage. The steam chest connects with control valves C, H, Q, T, *e*, *o*, *p*, *q*, Fig. 1, which are opened in the order named for increasing power. For lowest



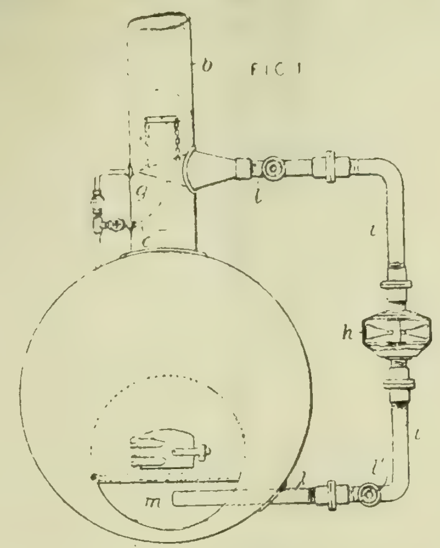
power steam from the valve C flows through the stages 1, 2, 3, 4 in series by way of nozzles D, E, F, G. For higher power the valve H is opened, and, being geared to a valve N, moves the same so as to open additional nozzle openings P leading to stage 2. Further increase of power is obtained by opening the valve Q, which admits steam to a bye-pass R and nozzles S, Figs. 3 and 5, leading to the stage 2. By opening the other valves specified above additional nozzle openings and/or bye-passes are brought into operation; for example, the first two or three stages may work in parallel with high-pressure steam. Fig. 6 shows means for interconnecting the valves, thus the valve A is actuated by a spur gear I operated by a spindle J serving to move a nut K and through a bell crank K1 to actuate a rack L, which in turn, through gearing M and another rack, moves the slide valve N.

LUBRICATING.

123,676. C. J. CURRAN, 28, Gordon Road, Cardiff.—June 15th, 1918. A loose pulley or a shaft bearing is lubricated through ducts in the shaft leading from a casing which is mounted on and supported by a shaft and is kept full of oil by a pipe from a container above the level of the bearing. The escape of oil from the casing is prevented by packing.

FURNACES.

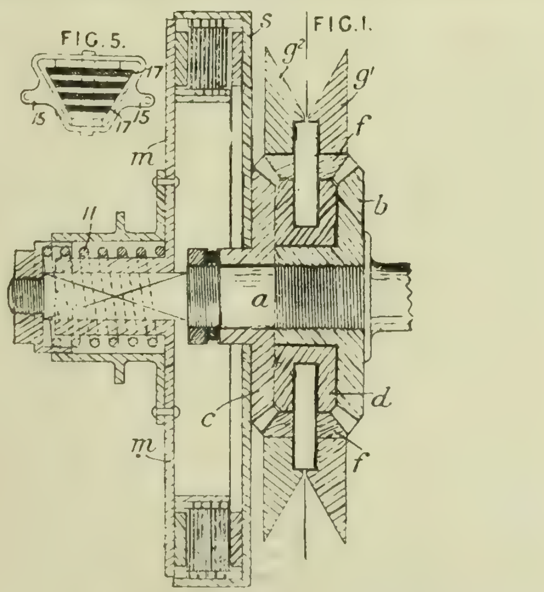
123,575.—W. A. WATTERSON, 1, Jet and Dredge, Macquarie River, Euchareena, New South Wales, Australia.—Feb. 25th, 1918.—To arrest sparks and to economise fuel in a furnace, a jet of steam is discharged from a nozzle *g* across the chimney, etc., *b* to carry the products of combustion through a pipe *i* into the ashpit *m*,



the pipe *i* being fitted with control valves *l*, *l*1 and with a mixing device in the form of a fan *k*. A second nozzle *c* may be arranged below the nozzle *g* to discharge a jet of steam into the chimney to steady the rush of the products of combustion, sparks, etc. As applied to forced draught, the fan *k* is replaced by a rotary blower, and the single nozzle *g* may be replaced by three nozzles, the centre one of which projects further into the chimney than the other two.

VARIABLE-SPEED GEARING.

123,703.—C. H. STRONG, 9, Palmerston Street, Romsey, Hampshire.—Dec. 13th, 1918.—A bevel epicyclic gear is combined with a plate friction clutch by the slipping of which speed changes are effected. A belt pulley *g*1, *g*2, Fig. 1, or other driven member carries bevel planet pinions *f* gearing with a sun wheel *b* fixed to a driving shaft *a* and with a sun wheel *c* connected to one member *s* of a plate clutch. The other member *m* of the clutch slides on the shaft *a*, and is operated by a lever and spring 11. When the clutch rotates without slip, the gearing drives solid



If the part *s* is held fast by a band brake, the pulley rotates at half the speed of the shaft. Other speeds are obtained by allowing the clutch to slip. In a modification, the bevel wheels are omitted and the pulley halves *g*1 *g*2 form the two sun wheels. They are engaged by conical rotating friction blocks 17, Fig. 5, mounted in frames 15 linked together to form a belt conveying power from the pulley to another pulley. A driven shaft may be in line with the driving shaft *a* and connected to the planet pinion carrier *d* by a cup-shaped fitting or stirrup. In another

modification, the clutch part s slides on the shaft a, but always rotates with the wheel c to which it is connected by dog teeth, and an operating collar fixed to the part s is furnished with a brake drum.

LUBRICATING.

123,707.—L. F. EASTON, 119, King Street, La Crosse, Wisconsin, U.S.A.—Jan. 2nd, 1919.—To lubricate two adjoining crank pins of an engine for motor vehicles, etc., a channelled ring 13, formed on its edges with trap flanges 17, is attached to the cranks at

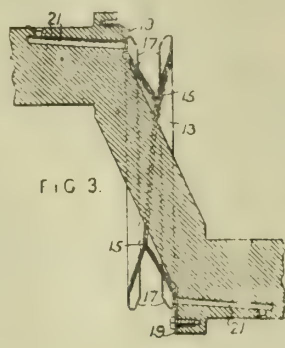


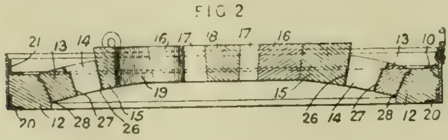
FIG 3.

19 and communicates with the surfaces of the crank pins by ducts 21. The ring consists of two conical parts formed with inclined meeting edges, welded together at 15. Oil is supplied by a fixed pipe to the channel and is delivered on to the two coned surfaces alternately.

FURNACES.

124,125.—P. J. GRIFFIN, 274, Bain Avenue, Toronto, Canada.—June 17th, 1918.—A furnace roof comprises an expansion ring

FIG 2



situated between the central body portion and an outer abutment ring. As shown in connection with a removable circular roof for an electric furnace, the outer ring of skew-back bricks 12 is secured by angle-irons 20, 21 in an outer metal ring 10. The expansion portion of the roof is formed by two rings of bricks 13, 14 which are shouldered to fit corresponding recesses in the skew-backs, and in the bricks of the outer of the two rings. Between the abutting faces 26, 27, 28, destructible spacing pieces of wood or the like are placed, and when these burn away, room is left for expansion. The central portion of the roof consists of rings of blocks 15, 16, 17, and a keyblock 18, which are formed to provide a flat upper surface, and openings 19 for the electrodes.

REVERBERATORY FURNACES.

123,778.—I. HALL, Kingsley Court, Edgbaston, Birmingham, and W. BAILEY, 6, Worsley Road, Patricroft, Manchester.—Aug. 25th, 1917.—In a reversible regenerative gas-fired furnace for melting steel, etc., a pair of converging gas ports 13 is employed at each

FIG 2

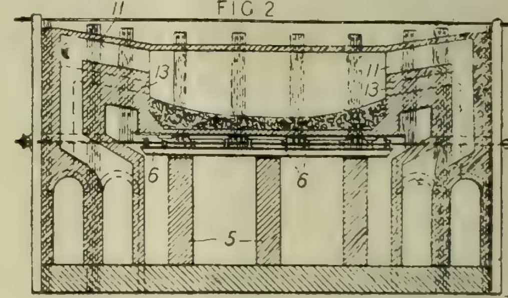
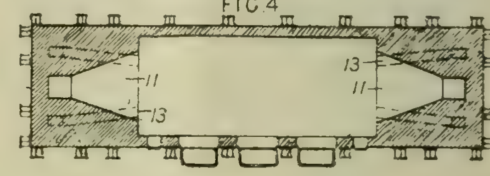


FIG 4



end in conjunction with a single air port 11 having diverging walls, so that the gas is concentrated at the centre of the furnace and surrounded on each side by a current of air which passes near the side walls. The hearth is separately supported on girders 6 and pillars 5.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

THE PENALTY OF EFFICIENCY.

THE penalty of inefficiency in a personal sense has received fairly general attention; in newspaper and journal, to say nothing of advertisement, omission in this particular has received severe castigation. Lack of reliability, of character, of success, have been pointed out so often that continual iteration leads the normal man to believe inefficiency must long since have been rectified, and he thinks the sermon on the hoarding is to the converted, who are in no danger of condemnation.

The penalty for inefficiency is severe; decadence is an easy, effortless path; indolence is pleasant, the mind is prone to dalliance, and an easy present can be balanced with effect against a problematical future. It is hard to imagine winter snow in the heat of August, and more difficult still for youth to believe in future distress, from want of present effort or deferred desire.

The art of living should be classified among the so-called fine arts, it needs keen insight to secure the best of both worlds—youth and age. Somewhere between the extremes of miss-spent youth and a youth spent entirely looking forward; between destitution in advanced years and wealth beyond the dreams of avarice lies rational life.

Accident and opportunity apart, real effort does eventually meet with some reward; the visionary castle may not materialise, but a fair measure of comfort and provision can be achieved by intelligence, capacity, and the will to effort. There are, however, dissentient voices from the gospel of all effort; temperament and capacity differ, and to have gained great possessions and lost the art of their enjoyment, or to have dulled the fine edge of the capacity to live, is to have failed most dismally, after all. Let it be said that while efficiency does involve penalty, it also avoids an immense waste of effort; on balance efficiency is preferable, provided always it does not involve the loss of the capacity to enjoy the means of living.

Work is a great consolation; well done it gives the reward of critical satisfaction; it also does more, it gives the necessary background against which to set relaxation, and gets existence into due perspective. Real and outstanding efficiency brings into play animosity. It involves disappointment because it is the efficient who have to provide the motive force, and be troubled by the lack of others who are untrustworthy, idle, or unintelligent. The outstanding fact about mental effort is that it further increases capacity, so that its difference grows greater and its critical ability more acute. Knowledge and insight increase the intensity of enjoyment, while at the same time the causes of annoyance and revulsion are multiplied.

Efficiency often results in an unfair burden: others are incapable, and as a consequence those able have to make good the deficiencies and supplement the lack of others. In any organisation it will be found that there are a few to whom in emergency the rest turn instinctively, they may not be popular, the efficient rarely are—but they can be relied upon to unravel tangles and find or win a way through some forbidding piece of work. Often the same folk are unable to dictate policy or effect the start, but are relied upon in extremity to sort out and untangle the ravelled skein when made. A reputation for efficiency does not always lead to comfort, it is frequently otherwise.

Efficiency brings its own reward, but it also inflicts disabling penalties; it is not enough that in ninety-nine cases it achieves results, but if it proves unable in the hundreth, the inefficient has the laugh and lets

his smile be seen. No man can live entirely regardless of his fellows, and a reputation for efficiency is not apt to make for affection or friendly feeling, it is too much like the strong light which beats upon one's fellow-man, who does not invite comparison to his disadvantage. Even the wisest trip at times, the most reliable err; diagnosis of complex symptoms may be wrong, we are all afflicted with a common humanity and the disabilities it entails. In more material connections with every provision made to ensure a first class job, now and again something plays false, some product is defective, and the criticism of use finds an unsuspected weak spot. Even the most reliable firms find it necessary to disclaim contingent liability, confining themselves to replacement or renewal of a faulty part, pointing out that though they exercise every care in supervision they are not omnipotent, and errors of workmanship or material may mar the wisest schemes. It is curious how a run of bad luck, as it is termed, will pursue an individual, or for that matter a firm, and while the universe is imperfect, and man's control more so, there will always be fault to keep us active. It is the impeding possibility which acts as an irritant to prevent indolence, and but for sheer necessity few would achieve competence. There is, however, the finer aspect of the whole matter—perfection approximate or absolute is the summation of a long series of detail factors, and in spite of the penalties of efficiency there is an impulse in the temperament of a large number which prefers efficiency with its drawbacks to incompetence with its indolence.

It is a mistake to assume that efficiency is only requisite in superior position; it exists and is needed in the most humble, who is indeed the better man if to his task he brings intelligence and capacity. No man is a failure if he is on top of his job; he is then ready for the next, and no essential service is despicable or unworthy if tackled in the right spirit by willing hands. Personal satisfaction is no mean end, and the present writer, brought into contact with numerous men in all spheres of engineering effort, can testify that efficiency with its rewards and penalties exists at all levels.

One outstanding characteristic is that the efficient recognise the efficient though occupation and status differ; there is the freemasonry of intelligence for a common bond, and it rarely goes unrecognised. Reward is to a great extent dependent upon understanding higher up the scale, and closer investigation at lower levels may result in surprising discoveries if the responsible man will investigate.

Some part of present industrial troubles lie at the door of those in control unable or unwilling to recognise efficiency, and the vast human differences in the men under their control. A little more sympathetic insight would have saved much unrest. We all share a common humanity, and organisation tends to interpose many opaque strata between management and man, to a lack of acquaintance between them. Technical skill and ability are not infrequently accompanied by a lack of the human understanding which senses and appreciates efficiency: it has only one measure, competence along a very narrow plane and is apt not to realise another point of view. It is, in fact, efficiency at the expense of understanding, and is one penalty of specialist concentration.

After all, Kipling's Diego Valdez may be right; he was High Admiral of Spain at the expense of his youth and the joy of living; it is considered he might have achieved as much without so great a forfeit, or have been the gainer with a lesser achievement.

Contentment dogs the footsteps of very few, but unquestionably it is only granted to those who feel and know they are of real service in the location they occupy. It is possible to be contented and yet to be ambitious; the combination may seem a paradox, but if the spirit to effort be right, there is a personal sense of satisfaction which is a very near relative of contentment.

The worst penalty of outstanding efficiency is isolation, separation from the mass, and only those who have achieved in the teeth of discouragement really understand.

FACTORY ELECTRIFICATION.

A MOTOR CAR, AERO-ENGINE AND AEROPLANE WORKS.

Manchester is a very busy centre of the aeroplane and motor car industry, and the General Electric Co. Ltd. have secured a considerable proportion of

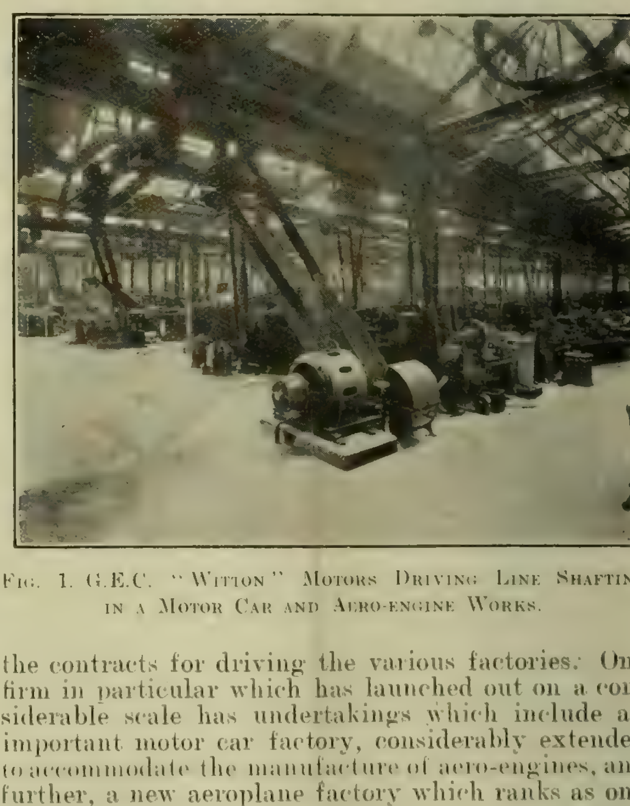

Fig. 1. G.E.C. "Witton" Motors Driving Line Shafting in a Motor Car and Aero-engine Works.

the contracts for driving the various factories. One firm in particular which has launched out on a considerable scale has undertakings which include an important motor car factory, considerably extended to accommodate the manufacture of aero-engines, and further, a new aeroplane factory which ranks as one of the largest, if not the largest, in this country. The complete equipment for these works has been supplied by the G.E.C., and can be taken as an example of the best practice in electric light and power installations. Incidentally the factories have been laid out for working night and day.

The motor car and aero-engine factories are supplied with three-phase power at 6,600 volts, 50 cycles. This power is brought into a sub-station where the G.E.C. have provided three 500 k.w. oil-insulated air-cooled transformers. From the low

tension side of the transformers three sets of 420 volt cables pass to the G.E.C. main switch board through isolating switches which enable the board to be made dead when required. The main switchboard,

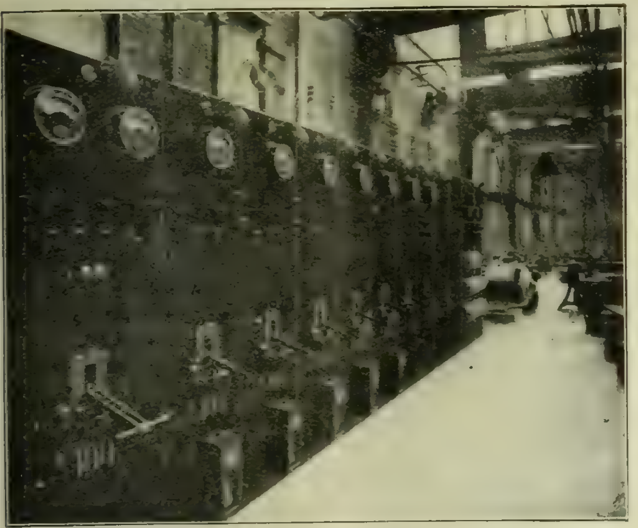

Fig. 2. G.E.C. Low tension Main Switchboard.

which is illustrated in Fig. 2, comprises twelve enamelled slate panels, of which one controls the incoming power to the board: of the remainder, eight are power and two are lighting distributing panels, whilst there is one spare. The transformer panel is equipped with a 2,000 ampere G.E.C. oil-switch with overload and no-volt trips, and includes an ammeter, voltmeter, current transformers, "Aron" energy meter, and the usual accessories. The oil-switch actuates a pilot lamp, which indicates automatically the position of the oil-switch.

Fig. 3. G.E.C. "Witton" Motors Driving Line Shafting.

The eight power panels have each an automatic oil-switch of varying capacity from 100 to 600 amperes, and include an ammeter, wattmeter, and graphic recording ammeters. In addition to the pilot lamp the oil-switches on these panels have a bell indicator signalling in the works when any of the switches automatically open. The two remaining panels are used to control the distribution of current for the lighting of the works.

Every one conversant with the economics of electrification will realise the importance of the advantage claimed that valuable economies in power can be made by the careful use of recording instruments, and an intelligent application of the deductions to be made from their records. The graphic recorders mentioned, it has been found, have proved of great value in this respect, and provide useful information in the matter of variations in power consumption.

From seven of the power panels mentioned, lead-covered and armoured "Pirelli-General" paper-insulated cables run to various G.E.C. staggered type Home Office pattern ironclad distribution boards. V.i.r. cables pass from these boards in heavy gauge screwed and welded G.E.C. conduits to the various motors. From the eighth power panel cables run to the motor-generator seen in the background of the

Fig. 4. G.E.C. "Witton" Motors Driving Line Shafting in Turning Section.

illustration. The function of this motor-generator is to supply continuous current to a number of machines from which the adjustable speed is required. These machines include several 4 H.P. adjustable speed "Witton" motors, driving gear quietening machines.

Cables are also taken from the main switchboard to four 45 kv.-a. and one 20 kv.-a. oil-immersed air cooled transformers for lighting, as well as to motor-generators of two and three k.w. capacity which are utilised for charging ignition and starting batteries for the motor cars, and for providing current for magnetic tables, clutches and similar devices.

It will be observed that the motor-generators mentioned provide a solution of the problem feared by some engineers as to how adjustable speed machines should be run from an alternating current supply. Parenthetically it may be said that this problem for large machines can readily be solved by utilising alternating current motors of special design,

but for very small outputs it is easy to adopt the solution decided upon in these works, and to put in continuous current machines designed for adjustable speed work, and to supply them from a special motor-generator.

G.E.C. "Witton" motors are employed throughout the works, and comprise the following:—

Four 100 H.P. slip-ring motors, 730 r.p.m.

One 60 H.P. slip-ring motor, 960 r.p.m.

Thirty-three 40 H.P. squirrel-cage motors, 725 r.p.m.

One 7½ H.P. squirrel-cage motor, 725 r.p.m.

One 12 H.P. squirrel-cage motor, 725 r.p.m.

Two 5 H.P. squirrel-cage motors, 950 r.p.m.

Two 1½ H.P. squirrel-cage motors, 1,450 r.p.m.

Eleven ½ H.P. squirrel-cage motors, 1,450 r.p.m.

Fourteen 4 H.P. continuous-current motors, 400/2,000 r.p.m.

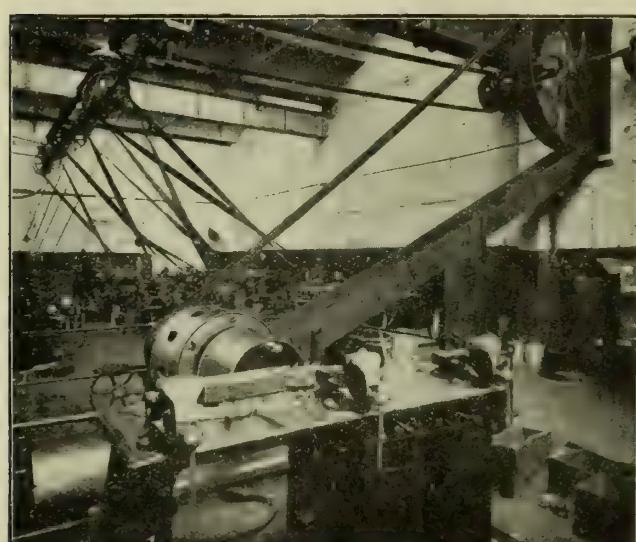

FIG. 5. 100-H.P. G.E.C. "WITTON" MOTOR DRIVING AUTOMATIC MACHINE SHOP.

One 27 k.w. motor generator, 950 r.p.m.

One 3 k.w. motor generator, 1,430 r.p.m.

One 2 k.w. motor generator, 1,430 r.p.m.

For starting the aero-engines on their test benches a 40 H.P. G.E.C. "Witton" motor has been laid down, driving a line shafting to which the engines can be connected.

The ½ H.P. motors in the foregoing list drive small portable machines situated in different parts of the works, whilst the "Witton-Kramer" electric drill has been extensively adopted, there being at present about 50 in use. The whole of the lighting throughout the works is carried out on the direct system, there being over six hundred 18 inch vitreous enamelled G.E.C. "Munition" reflectors for Osram lamps (Atmos type) of various candle powers, which are supported from the roofs by means of light link chains. In the offices the semi-indirect system of lighting has been selected, and 18 inch "Equiluxo" bowls are used for this purpose.

A NATIONAL POLICY OF COAL CONSERVATION.

(*Continued from page 112.*)

Uses of Coal in which Complete By-product Recovery is, or should be, possible.

Coking (iron and steelworks)... Gas making (gasworks) .... Domestic	Say, 45 per cent of the nation's total consumption.

In 1913 we actually carbonised –

10 per cent in gasworks 7 per cent in coking plants	= 17 per cent.

If we take the consumption of coal in the United Kingdom for the three purposes named, we find that it is 45 per cent of the whole. So that we ought now, or in the near future, to be able to carbonise some 45 per cent of our total consumption. I find that in 1913 we carbonised approximately 10 per cent of the coal in gasworks, and about 7 per cent in by-product coking plant, or a total of 17 per cent only. We might have carbonised about 25 per cent. Certainly we ought soon to realise more than this figure, in view of the possibility of carbonising part of our domestic supply.

A partial recovery of by-products ought also to be possible in regard to the coal consumed for power purposes. It should be our object in investigation or research to try to expand the possibilities of by-product recovery in regard to certain classes of our coal that are used for power production. I do not say we shall find it possible, or even desirable, to carbonise, either partially or completely, all the coal required for power production. I am not putting forward an ideal like that. We are not yet far enough developed; but at present we ought to be devoting ourselves to investigating the possibilities in that direction.

Let us consider what we are likely to get out of coal carbonised at a low temperature. I mean by "low" a temperature between 500 deg. and 600 deg. C. If we carbonise at this temperature, we ought to select a coal that will give a residue which is either naturally coherent or which can easily be briquetted under pressure. We shall obtain from it, as a rule, about 70 to 80 per cent of its weight of what I call "semi-coke." This "semi-coke," if it could be prepared in a condition that would stand transport and distribution, would be an excellent fuel for burning in household fireplaces. Then there is a comparatively large amount of condensable tars or liquid products. These products would consist chiefly of what the chemists call the naphthene series of hydrocarbons. There is here one very important difference between low and high temperature carbonisation. You have all heard how the benzols and toluols (the benzol hydrocarbons) have played an extraordinary important part in the war. We derive from them the high explosives which we have used so effectively in the war. They are also the basis of coal-tar dyes; and we also prepare from them a number of synthetic drugs, disinfectants, etc. These valuable hydrocarbons are not found in the tars produced at low temperatures. According to investigations made in my own and other laboratories low-temperature tars are mainly composed of hydrobenzols. These, and not the benzol hydrocarbons, are the chief constituents of the tars produced in low-

temperature carbonisation: and the amount is about 6 to 10 per cent of the weight of the coal, according to the kind of coal. In addition, a small amount of fairly rich gas is obtained, varying with English coals from 2,500 to 4,000 cubic ft. per ton, or more in the neighbourhood of 3,000 cubic ft. than any other figure. This gas is very rich in paraffin hydrocarbons—methane, ethane, etc., but it contains only a small proportion (less than 15 per cent) of hydrogen. One other important point I must not forget. At such low temperatures we do not get much ammonia. It would not amount, as sulphate of ammonia, to more than between 6 lb. and 8 lb. per ton of coal.

Commercial Prospects of Low-temperature Carbonisation.

The chief difficulty about the wider adoption of low-temperature distillation is a commercial one. The prospects would be decidedly good if only a good "semi-coke" which will stand transport could be produced. Another difficulty is that the present commercial value of the tars is not great. The naphthenes could be used as motor spirit and fuel oil. But they cannot be made the basis of coal-tar dyes, unless indeed they are cracked; and then the coal might just as well be distilled at high temperature straight away. It is quite possible technically to carry out the low-temperature process; but the commercial prospects have so far not been very encouraging, although changing circumstances may favourably affect them. I for one hope to see the day when low-temperature carbonisation will not only be more technically perfect than it is now, but also when the commercial prospects of it will be better. And there are already signs of that day arriving, perhaps more quickly than some people think. I myself have quite an open mind on the subject, and think that possibly some "intermediate" temperature (say *circa* 700 deg. C.) may be found to yield a sufficiently good combination or results to make it an attractive commercial proposition.

At any rate, it seems worth trying, in view of the need of a "smokeless" domestic fuel and of larger supplies of motor spirit and fuel oils generally.

High-temperature Carbonisation.

Let us now consider carbonisation at high temperatures, by which I mean at temperatures from, say, 900 deg. to 1,100 deg. C. If a suitable coking coal is chosen from among the hard coking series a hard metallurgical coke is produced. Also benzene, toluene, benzenoid and phenolic tars, plus a considerable amount of ammonia, are obtained. The resulting "coal gas" also contains a number of constituents, the nature of which we shall discuss later on. High-temperature carbonisation has been carried out in this country on a large scale for about a century, and is so well-established an industry that its prospects do not require talking about, because they have already been realised. Now the important question arises: how, in the public interest, should this process of high-temperature carbonisation be carried out in future, and what should be aimed at in regard to public gas supplies? I therefore propose to discuss one or two changes that may possibly come over the carbonising situation. We are at present in a state of transition or flux. A great many competent people are thinking about carbonisation problems, and what our future policy should be. They do not all agree; and I may have to refer to proposals with which I do not personally agree. But I think it right to give you, as far as possible, not only an unbiased, but a reasoned, statement of the pros and cons of the various suggestions that have been made.

When the best types of British "coking coals" are carbonised in coking chambers, with by-product recovery plant attached, for the manufacture of hard metallurgical coke, there are usually obtained:—

	Percentage of weight of dry coal.
Coke	between 67·0 and 75·0
Tar	,, 2·5 and 4·0
Benzols	,, 0·6 and 1·4
Ammonium sulphate	,, 1·0 and 1·4

Surplus gas: between 3,000 and 5 000 cubic feet per ton.

The "debenzolised" gas contains:—

$$CO_2 = 2{\cdot}5,\ CO = 6{\cdot}5,\ C_nH_m = 2{\cdot}0,\ CH_4 = 25{\cdot}0,$$
$$H_2 = 55{\cdot}0,\ \text{and}\ N_2 = 9{\cdot}0\ \text{per cent},$$

and its gross calorific value, per cubic foot at 15 deg. C. and 760 mm., is approximately 485 B.Th.U.'s.

When "gas coals" are carbonised in gas-works retorts, similar products are obtained, the chief difference being that the coke yielded is inferior, both in quality and quantity, to that obtained in coke ovens, whilst the gas is richer and more abundant. Also, whereas coke ovens are fired by a portion of the "debenzolised" gas (about half of it is so required), gas retorts are heated by "producer gas" generated in the setting from part of the coke produced. Thus, for example, a good Derbyshire gas-coal yielded, when carbonised at about 1,000 deg. C. in horizontal retorts:—

Coke = 63·0 per cent of the weight of the coal charged.

(N.B.—about one-eighth part of this coke was used to fire the setting.

Tar = 10·5 gallons (sp. gr. = 1·19) per ton of coal.

Ammonia Sulphate = 28·5 lb. per ton of coal.

Gas = about 12,000 cubic feet, at 15 deg. C. and 760 mm., per ton of coal.

The gas contained:—

$$CO_2 = 2{\cdot}60,\ CO = 5{\cdot}20,\ C_nH_m = 3{\cdot}30,\ CH_4 = 34{\cdot}00,$$
$$H_2 = 43{\cdot}50,\ N_2 = 11{\cdot}40\ \text{per cent.}$$

Its calorific values would be about 590 (gross) and 520 (net) B.Th.U.'s per cubic feet at 15 deg. C. and 760 mm

If the heat balance of such a process were investigated, it would be found that, after deducting the coke required for firing the setting, the potential energy of the residual coke available for sale would be about 50 per cent, of the gas about 25 per cent, and of the tar about 5 per cent, that of the coal carbonised. In other words, the thermal efficiency of the process would be about 80 per cent, which, it must be admitted is a very satisfactory result. Indeed, it has been stated that the two Metropolitan Gas Companies, which in the year 1913 carbonised 3·114 million tons of coal (or about one-fifth of the total carbonised by all the authorised gas undertakings in the Kingdom), actually sent out of their works, in the form of coke, gas, and tar, a little more than 70 per cent of the potential energy of the coal taken into them. The gas actually sold accounted for nearly 25 per cent of the total energy of the coal employed in making it. It would thus

appear that, taking the process as a whole, the thermal efficiency is commendably high.

Nevertheless, many competent judges are of the opinion that the time has come when gasworks ought to send out a much greater proportion of the potential energy of the coal in the form of gas than they have hitherto done, and the endothermic interaction between steam and incandescent coke, productive of "water gas," is readily available for such purposes. In other words, a combination of "carbonisation" and "water gas" processes is now advocated as a means of increasing the proportion of energy sent out in the gas, at a corresponding sacrifice of part of that hitherto made available in the coke.

Steaming Vertical Retort Charges.

Investigations have been made with the object of trying the effect of introducing steam under pressure at the bottom of the vertical retort during carbonisation. The idea is, of course, to utilise the heat in the incandescent coke to generate water gas; and this gas passing upward materially assists in the distribution of heat in the retorts. These steaming experiments have been highly successful, and it is probable that the practice of steaming the charges in vertical retorts will become common. I may quote the results from one series of experiments.

Steaming of the Charge.

[Steam introduced at 40 lb. pressure through a $\frac{1}{8}$-in. nozzle.]

Result: 16,600 cubic feet of gas per ton (instead of 14,000 cubic feet without steam).

Percentage composition—

CO_2	CO	C_nH_m	CH_4	H_2	N_2
3·7	17·1	2·2	20·0	57·2	5·0

B.Th.U.'s in gas per ton = 8,386,000, or, say, 28·0 per cent of the potential heating value of the coal.

The coal used normally gave 14,000 cubic feet of gas per ton. Steam was introduced at 40 lb. pressure through a $\frac{1}{8}$-in. nozzle; and the result was that the gas production went up to 16,600 cubic feet—or an increase of 2,600 cubic feet—containing some 20 per cent of methane, 57 per cent of hydrogen, and 17 per cent of carbonic oxide. In the ordinary carbonisation process the potential heat in the gas was about 23 per cent of that of the coal. By steaming, this was increased to 28 per cent, at the sacrifice of some of the coke. If it is desired to get more heat units into the gas, then this policy of steaming retorts is to be commended.

Effect of Gasifying the Whole of the Coke.

There is, however, a further possibility to consider. Many people believe that, instead of our gas undertakings selling both coke and gas, as heretofore, it would be better for them to gasify the whole of the coke in a water-gas generator, and to send out, through the public mains, a mixture of blue-water gas and coal gas. In this way, there could be produced, and sent out from the works, about 50,000 cubic feet per ton of coal of a "mixed gas" of somewhat the following composition:—

CO_2 = 3·5, CO = 35·0, C_nH_m = 1·0, CH_4 = 7·0, H_2 = 50·0, and N_2 = 3·5 per cent.

Its calorific values would be 370 gross and 320 net B.Th.U.'s per cubic foot at 15 deg. C. and 760 mm.

Looked at from the standpoint of thermal efficiency, the total energy sent out in the form of gas from such a works would now be about 57 per cent of that in the coal taken in, or, say, about 62 per cent if the thermal value of the tar produced were included in the balance. The adoption of such a plan, whilst it would involve a very considerable gain in regard to the proportion of the coal energy sent out as gas, would mean, on the whole, a marked diminution in thermal efficiency as compared with present practice. But its advocates claim that, inasmuch as gas can be burnt with greater efficiency than coke, the public would be the gainer by its adoption. Also, they aver that the public would get heat units in the form of gas more cheaply than they would otherwise get them under a continuance of the older practice.

(*To be continued.*)

DRIVING BELT DECAY.

WITH NOTES ON A PREVENTIVE.

By James Scott.

All organic substances are subject to gradual disintegration through the agency of chemical factors which are either directly introduced into them from fumes, vapours, and moisture, or else are constitutionally formed by the presence and action of injurious bacteria, moulds, mildews, and kindred minute vegetation.

In this category must be placed driving belts, whether they are composed of leather, woven cotton, canvas, balata, or any other fibrous material. Although damage may remain undetected until it becomes obvious and irremediable, it is none the less progressive in minute stages, which are observable through the microscope. Clues afforded in this manner enable us to determine the nature of the mischief, and by preventing its extension avoid the occurrence of dangerous extremes, which would appear in the absence of such supervision. Engineers who customarily use a good belt preservative may be under the impression that its application merely keeps the goods supple and smooth; but this is not exclusively so, because its tendency is also to inhibit the growth of germs and fungus spores, and counteract the possible effects of deleterious gases, humidity, etc.

The tanning of leather is a more complicated process than many people are aware. A large number of products—barks, woods, fibres, and galls—enter into the industry, but the tannin contained in them is not a single constituent of regular character. Indeed, there are several varieties of tannin, the principal ones being: pyrogallol-tannin, gallotannin, catechol-tannin, and ellagi-tannin.

Tannin, by the way, is feebly acid, and for this reason is often called tannic acid.

There is no space, nor is there any need, to go deeply into their distinguishing phases, but it is advisable to point out that according to the kind of tannin present in leather so depend the particular faults which are likely to become visible in it. There are three notable forms of leather defects, known as "bloom," "whites," and "reds," to which references will be hereafter made.

"An unfortunate peculiarity, apparently common to all catechol-tannins is that, however light-coloured the leather produced by them, it darkens and reddens rapidly by exposure to strong light, and ultimately becomes quite friable and rotten." Thus says

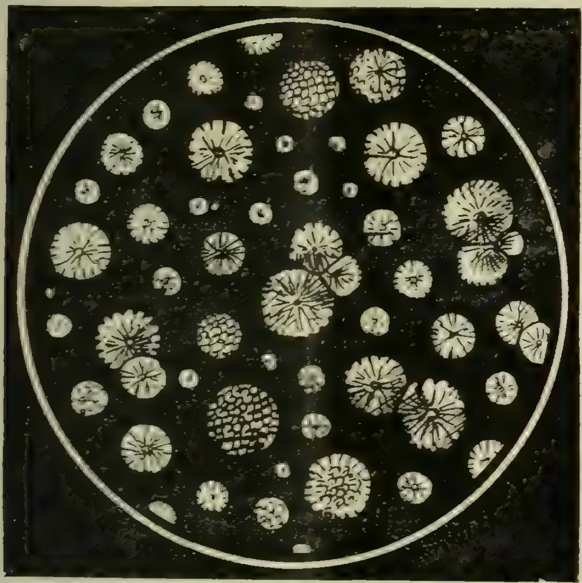

Fig. 1.—One-twenty-fourth inch of a layer of crude catechin dissolved from tanning products. This substance appears on leather belts as either *white* or *red* patches, etc. Magnified.

Professor H. R. Proctor, F.I.C., F.C.S., on page 298 of his standard volume on "The Principles of Leather Manufacture," one of the most important in this industry.

The catechol-tannins, which are very important, contain a colourless, crystallisable substance known as catechin. This is only slightly soluble in cold water, but is very soluble in hot water. Although catechin does not tan, it is believed to be the actual source of tannin, and that some of it changes into tannin in the leather while the latter is being treated in the tanyard.

When catechin is in excess in a leather, and merely gets forced to the surface, it produces colourless, scattered spots and patches composed of masses of its tiny crystals, the disease being called "whites."

Catechin, when heated, loses water and is changed into a resinous red state, and the disfigurements then brought into evidence are called "reds.'

"Whites" are more likely to arise on leather belts used in factories, workshops, mills, etc., where the temperature is not very high; whereas "reds" will show instead when there is much heat to be encountered. This resinous exudation is allied to the remarkable resin known as dragon's blood.

Pyrogallol-tannins are often responsible for giving a delicate grape-like, but whitish bloom to leather containing them; this disease, spoken of as "bloom," appearing as very minute crystals of ellagi-tannin and gallo-tannin in a decomposed state as ellagic-acid and gallic-acid—mostly the first-named. The crystals glisten or shimmer prettily. This change causes the leather to become hard, close-textured, and brittle.

Tannin, when acted on by iron, forms inks of various blue shades. The dark, murky hue of tea as a beverage is due to the combination of tannin and the iron dissolved in the water from which it has been made. Similarly, any iron rusted or dissolved off machinery in contact with leather belts, by means of acid fumes, will impart dark blue or, maybe, nearly black, stains to the material. This kind of blemish has often been noticed by engineers without its cause being fully known.

In cases where the dark discolouration tends towards greenness, it may be concluded that the tannin with which the leather has been impregnated consists largely of catechol-tannin.

Tannin is uncrystallisable, and when free and isolated is a pale-brown powder capable of darkening to a dense, pitchy mass. Therefore, when crystals are found they are not tannin, which should—but does not always do so—combine permanently with the fibres of the skin which it has converted into leather.

In Fig. 1 is shown a portion of a layer of crude catechin dissolved from gambier (a common tanning material) by treating it with alcohol and then evaporating the spirit. Discs of the substance are left, and can be melted, needle crystals subsequently appearing in the film as it cools. Similar crystals can be obtained from it with boiling water.

Turning to cotton, canvas, and similar fibrous belts, it must be stated that the most notable maladies from which these things suffer are of a fungoid nature. Chief among the micro-fungi thus concerned is that known scientifically as *Chætomium elatum*, or *cornatum*; and among hobby naturalists as bristle mould. It begins by the formation of clusters of slender ordinarily invisible threads or filaments, which sprout from bead-shaped spores that get into the meshes of the fabric from the air. These filaments give rise to tiny black spore cases,

Fig. 2—Magnified canvas and cotton belt fungi or moulds, which appear to the naked eye like specks of soot. One case is young (centre), another mature, and the third scattering its spores.

enveloped in branching tufts. Each case is to the naked eye a mere speck, like the full stops and dots to the i's on this page, and when an attack is severe, the belt looks as though soot had been sprinkled upon it.

The spores are liberated by the bursting of the cases, and each one has the power to start a new colony of the fungus on its own account. In thus growing among the threads of the belt the mould set up a fermentative rotting action upon them, and they rapidly sever under the slightest strain.

If fabric is left to itself a long time with this fungus in it, the whole of the fibres will become so bad that it is possible to crumble them between the fingers to a fine dust.

Driving ropes are also attacked by this fungus, which is shown in Fig. 2 in side view on the surface of folded fabric.

It must be strongly emphasised that diseases both of leather and fabric can proceed uninterrupted by the rushing movements of the working belts composed of them if the goods are not properly cared for. The spores and crystallisations are no more impeded than is the freedom of movement of a man who is travelling in a railway train, however fast it may go.

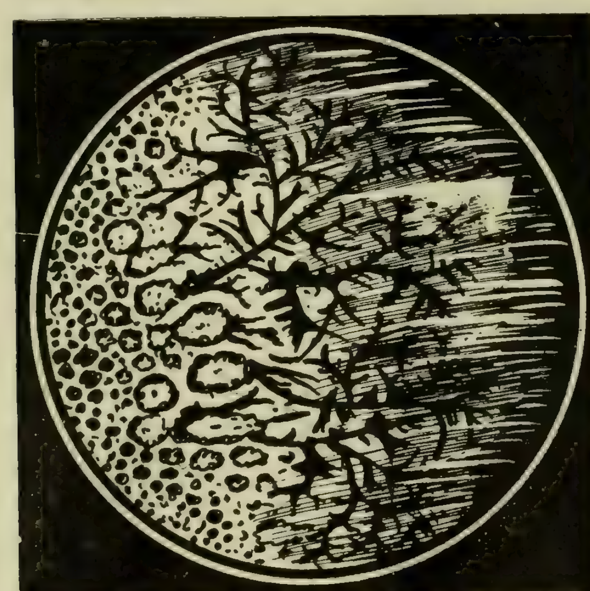

Fig. 3. – One half-inch of a suction film of "Maxa" belt preservative. The spaces enable the material to cling tenaciously to the metal. Magnified.

Naturally, however, in belts which are compelled for any reason to remain stationary for several days or weeks, diseases have a chance to spread at a quicker rate, because vapours, fumes, and so on can more steadily permeate among their innermost parts.

One of the most effective remedies for the prevention of the faults described is "Maxa," although its proprietors do not claim any merit for it in this direction. Few people, indeed, are aware of the real incidents responsible for the ruination of leather and fabric belts, owing to the minuteness of the objects concerned therewith.

Weakness occasioned by the presence and influence of automatic crystallisations and moulds are intensified in circumstances where belts run too tight, and are therefore strained.

The preservative named enables belts to run wholesome and slack, as it is non-sticky, undryable, and devoid of either acids, alkalies, resin, or other injurious ingredients. It soaks right into the inner recesses of leather and fabric; and by blocking up the pores does not allow germs or moulds, or chemical changes to gain sway.

If an even layer of this substance is spread over a strip of glass, and another glass is pressed and pushed in one direction upon it, suction cavities or lines and spaces will appear. Carefully, and quickly, lift up the top glass as though it were a book cover (that is, while one edge is kept still against the lower glass), and then note, through a lens, the curious figurings produced on the glass, as shown in Fig. 3. They prove that the softer and denser ingredients are so well mixed that, as the preservative works between the travelling belt and metal, little hollow sucking places, and tenacious, elastic clinging strings together prevent slip and other undesirable traits.

CAR DESIGN AND CAR USAGE.*

By Edgar N. Duffield.

By way of preface the author wishes to state that he has never until the past summer even considered the question of designing a car or any part of a car. He has been moved to contribute this admittedly amateurish paper by a remark uttered by a gifted automobile engineer during the discussion upon the paper on "The Lubrication of Motor Cars" read, in March, 1919, by Captain G. W. A. Brown,† who designed the current model of the Arrol-Johnston car—a design which, members will probably agree, is one of the most suggestive that has been given to us in the past ten years. Captain Brown having pleaded in his paper for methods of lubrication which would be simple to operate, and so be likely to be used regularly, Colonel Barrington, in the discussion, said that one of the troubles with which the designer of cars had eternally to contend was the laziness of the average person into whose hands a car falls. Now this is very true—the average car user hates lubricating, but as this is so, always was so, and always will be so as long as cars are troublesome to lubricate, designers should accept that condition of things and design accordingly.

The author feels that the fact that he has never designed anything that has worked does not in the least degree invalidate his right to criticise, or at least suggest. He has been living principally upon selling, repairing, demonstrating and writing about cars for sixteen years. He has written journalistically, he has conducted technical correspondence, helping car manufacturers' customers to get the best of service from their cars, and he has written numberless instruction manuals and literature of that sort. He has handled, for periods ranging from two to three hours up to a whole year, cars of British, French, German, Belgian, Italian and American construction. He has had them new, used and played out. He has bought and sold, maintained and overhauled, rebuilt and repaired them and their parts, and so has come to acquire quite a useful idea of their merits and demerits, individually and in classes. That is all. Those who would question his

* Published by the authority of the Institution of Automobile Engineers, 28, Victoria Street, Westminster, S.W.

† See Proc. I.A.E., Vol. XIII., p. 299.

right to theorise, on the statements of this confession, need follow him no farther.

The author's first point is that cars are bought for *use*—for *transport service*. If the designer of Colonel Barrington's type of mind says he knows that, the author says that he does not *appreciate* what he knows, so long as he complains of the laziness of car users on matters like lubrication. The buyer buys to use, *not to lubricate*. He wants to do just as little adjustment, cleaning and lubrication as he can, *because he bought to use*, and *not* to adjust, clean or lubricate.

There is, of course, a type of buyer who really enjoys adjustment, cleaning and lubricating—who is never happier than when he is "tinkering" with his car, but the author does not envy him, and his experiences as a sales and service manager teaches him that this type of customer is seldom of any real help to a manufacturer of cars. For one of this type who keeps a "Blank" car running better than the majority of other "Blank" cars, there are at least ninety-nine who, sooner or later, reduce the "Blank" to being "junk." And no firm can afford to have any of its cars turned into "junk," even to amuse the most enthusiastic adjuster, cleaner and lubricator.

Cars, being bought for use, should be designed for use, and use only. The author is able to admire a pretty job just as heartily as the man who first put that job on paper, but if its prettiness makes it a little more troublesome or difficult to adjust, clean and lubricate than is a less pretty job, then he reflects that beauty is only skin deep, and looks elsewhere to spend his money. Let us have pretty cars, by all means; let us have cars that will appeal to the most advanced students of technics, but let them at the same time be cars that can be kept running efficiently and cleaned and lubricated without undue expenditure of time or trouble.

It may be thought merely silly that the author should put on record that he thinks the Ford a better users' car than the Rolls-Royce. But he does say that, and means it, for one simple reason—that the Ford can be kept running like the best of Fords with far less expenditure of time and trouble than the Rolls-Royce can be kept running like the best of Rolls-Royces. For his own driving he would naturally rather have one Rolls-Royce than ten Fords, but then he is by no means a representative fool. Designers have to legislate for fools. There is no need to mince matters. The majority of people who buy cars and use cars *are* fools, mechanically speaking. It is in the author's experience that a man who would not dream of interfering with the insides of a seven-and-sixpenny watch will cheerfully eviscerate a £750 car. He would call in a Singer mechanic to adjust his wife's sewing machine, but he will poke about inside his car, costing a hundred times as much, as though he were a direct descendant of Gottlieb Daimler, with all the mental advantages such lineage should suggest.

It is not a bit of good for Colonel Barrington, or any other equally skilled engineer, to cry about the foolishness of fools. It is there, just like friction or momentum or heat, and what the designer has to do is to navigate around it—either to use it to help his own job, or so to do his own job that its consequences will not be detrimental thereto. For this reason, designers must come down on to the author's cheap, undignified level and make their cars more like Fords and less like Rolls-Royces. True, they should not go too far in this direction, but they can go quite a long way before they do any serious damage to the future of automobile engineering, either moral, intellectual or material.

The author says that the Ford is a better users' job than the Rolls-Royce because there are fewer things to do in, on and about it. He has never owned either of those cars, but he knows that if he had a family of ten boys and gave them ten Fords, while his brother gave his ten boys ten Rolls-Royces, the author's progeny would be having good times while his brother's were still in the motor house getting ready to go out. That is the test. We have to regard the potential buyer as certainly wanting service, rather than trouble in the motor house, and probably as a fool. If he isn't, so much the better for the reputation of whatever car he buys. But the designer must start out with that notion in view, and design for him on that notion.

It will always be necessary to adjust, clean and lubricate cars, even if we get cars built upon the combined design of the whole Institution; but certainly designers must do every last thing they can to simplify the carrying out of, and reduce the necessary frequency of, those processes. Even a Rolls-Royce would be a greater car than it is if it could be filled up with lubricant just as it can be filled up with fuel and cooling water. Everybody who uses it enjoys the refinement of its performance, and a lot of its users must admire, must positively reverence, the beautiful detail-elaboration which gives that degree of performance-efficiency. But the Rolls-Royce Co. would never pay big dividends upon the patronage or custom of the minority who buy their cars as toys—to play with all the intriguing little gadgets with which they are fitted.

Design has gone as far as it need, for a while, in the matter of power-development. Nobody wants any more power than is available to-day if he knows what to buy. The job marked out for design to-day is one of weight-reduction, suspension-improvement and maintenance-simplification.

Ten years ago, when the author first met Mr. Laurence Pomeroy, he gladdened him by the use of the phrase, "fewness of bits." This, he said, was a classic virtue. He impressed upon the author that it was immoral to use four parts if two would do the job. He was right then, and his principle stands now, although certainly the Vauxhall of to-day is a much more elaborate production than was that of 1909, which was under discussion. Fewness of bits *is* a great merit. It makes for what the author and all the other buying public want to see. It makes for weight reduction and maintenance simplification, and it can also be quite a useful guiding light in the matter of suspension improvement.

If designers came more into contact with users they would save themselves a lot of worry. If they stood more frequently in the showroom or the repair shop, they would meet people who—for the moment—would give them severe shocks, but when they had considered things a little they would see that *their job was to cut out parts, not to add them*—to see how many bits they could keep out of their new chassis.

It is difficult, certainly, to see how improvement of design can protect the designer from the type of

person illustrated in the following two cases. The author has had an intelligent-looking, nicely educated British gentlewoman drive in by car from her home, two miles away down a hilly road. Steam was issuing from the threads securing the water-filler cap on its radiator, which was found to be all but empty. In reply to a question, the lady said: "There was not much in, I know. I poured in a jugful, you see. Grant was out, but I knew a jugful would be enough to bring me up here."

The other case was that of an experienced owner-driver, a man who had run his own cars for ten years, who boasted that he saved pounds sterling per annum by regularly draining off, filtering and so using over and over again his engine oil. This he habitually did, apparently, until a notably "heavy" gas engine oil, prepared for use in stationary engines, was reduced to the viscosity of the lightest castor blend sold. This excellent fellow could not appreciate the expensiveness of his "economy," although he regularly required a new main, connecting rod or camshaft bearings every four or five thousand miles. Oil was oil to him, and always would be while it maintained its fluidity. He was constantly asking if tighter piston rings would not "prevent the petrol leaking past them and thinning the oil, so that his bearings ran." It was clear that he regarded the author as a dull, matter-of-course, rule-of-thumb person when he told him that his trouble was due simply to poverty of oil. He thought that oil remained oil so long as there was any left, and the suggestion that his oil waned in quality as it became reduced in quantity simply made him cross.

Now that is the kind of owner-driver we get, and these instances are given as actual, truly-recorded examples of the abysmal ignorance and criminal carelessness of some of the people by whom cars are used. That is why the author says that designers must not gnash their teeth and wring their hands about users being too lazy and too careless to oil-up and adjust at decent and reasonable intervals, but must give us cars which can be oiled efficiently by replenishing the irreducible number of reservoirs, big and little, and so designed that the necessity for, the bare possibility of, adjustment will also be irreducibly minimised.

These are the author's main points. All that follows tends merely to emphasise or support them. The matter of weight-reduction comes in because lighter cars, of a given power output and load capacity, should inevitably be cars making less and less demand for adjustment and lubrication, for reasons which, before such an audience, probably need not be gone into.

Suspension is a very hard nut to crack. The eternal problem seems to be the provision of a springing system which, fitted to a seven-seated car, will be equally satisfactory whether that car carries two or seven people. To provide such suspension is a matter calling for real genius, and the author has never yet come across a car so sprung that it was not either too well suspended when running lightly laden, or insufficiently suspended when running with all the seats occupied.

The author's own observation suggests that where expense is a prime factor, there is nothing better than a set of four half-bow, or semi-elliptic, springs as long and also as wide in the main leaves, and as flat in the camber, as is practicable. Lanchester springing is certainly splendid, but it costs money, and "Lanchester *type*" springing, as offered by some American (and not a few British) manufacturers, is perfectly hopeless.

The author has analysed (by which he means carefully examined) nine distinct types of suspension, but to no very fruitful purpose, because to get useful data their actions must obviously be observed upon an identical car, run during each test under identical conditions, which calls for more time and money than he has ever been able to devote to research. He is, therefore, in a position to offer no suggestions upon suspension which are at all likely to be of service to those who have given this detail real and honest study.

We all know the system of engine oiling by which the lubricant is pumped to the crankshaft bearings through oil-ways drilled in the shaft. It looks good, and it works well, as long as the sump is full, the pump works, and the oil-ways remain free. But it is costly in application, and drilling shaft-webs does not improve the shafts, while if ever a hold-up in the oiling circuit *does* occur, matters are just as serious as if the sump had been carried away by a boulder.

Careful inquiries indicate that overheatings and seizures of engines (due to defective oiling) are no commoner in splash-oiled engines than in those lubricated by forced feed through drilled shafts, and that heavy carbon deposit in splash-oiled engines is often due simply to over-rich mixture and defective cylinder or piston ring tightness. They show, too, that some very reputable firms, both British and foreign, are satisfied with splash lubrication, and indicate that excessive carbon deposit is not *commonly* more excessive in splash-oiled than it is in forced feed-oiled engines, especially those run at light compression.

This being so—and it may be accepted that it is—does it not seem a pity that money spent upon drilling oil-ways should not be diverted into some direction in which it would be of greater real service, at least in the case of the less expensive cars, the so-called "light" cars which are up to now used principally by people who *do* know something about cars, and treat them decently?

(To be continued.)

Certified Engineers in Queensland. Under new Local Government legislation which is being introduced into Queensland, there are regulations affecting the certification and employment by local authorities of authorised engineers. The Governor-in-Council may, by the regulations, provide for: (*a*) The employment of certificated engineers; (*b*) for the circumstances and conditions under which exemptions from the employment of certificated engineers may be granted to local authorities; (*c*) the qualifications necessary for the grant of certificates; (*d*) the conditions under which two or more local authorities may join in the appointment of the same certificated engineer; (*e*) the classes of works upon which the local authority shall employ a certificated engineer. With regard to the proposed termination of employment of any clerk or engineer, the local authority shall either order an inquiry or suspend the officer. If suspended, the local authority must state the reason for his suspension. The officer may then apply for an inquiry, and if an inquiry is asked for, it must be held by some person appointed by, but not a member of, a local authority. If the local authority and the officer concerned so agree, the inquiry may be held in private, otherwise it shall be public. The person holding the inquiry reports to the local authority, and the report must be read in open meeting. Where an inquiry is ordered, no decision shall be given by the local authority until after the reading of the report.

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 56 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 0 0	10 0 0	15 0 0	1 0 0 0	1 5 0 0	1 10 0 0	1 15 0 0	2 0 0 0	2 5 0 0	0
1	0 2 0	5 2 0	10 2 0	15 2 0	1 0 2 0	1 5 2 0	1 10 2 0	1 15 2 0	2 0 2 0	2 5 2 0	1
2	1 0 0	6 0 0	11 0 0	16 0 0	1 1 0 0	1 6 0 0	1 11 0 0	1 16 0 0	2 1 0 0	2 6 0 0	2
3	1 2 0	6 2 0	11 2 0	16 2 0	1 1 2 0	1 6 2 0	1 11 2 0	1 16 2 0	2 1 2 0	2 6 2 0	3
4	2 0 0	7 0 0	12 0 0	17 0 0	1 2 0 0	1 7 0 0	1 12 0 0	1 17 0 0	2 2 0 0	2 7 0 0	4
5	2 2 0	7 2 0	12 2 0	17 2 0	1 2 2 0	1 7 2 0	1 12 2 0	1 17 2 0	2 2 2 0	2 7 2 0	5
6	3 0 0	8 0 0	13 0 0	18 0 0	1 3 0 0	1 8 0 0	1 13 0 0	1 18 0 0	2 3 0 0	2 8 0 0	6
7	3 2 0	8 2 0	13 2 0	18 2 0	1 3 2 0	1 8 2 0	1 13 2 0	1 18 2 0	2 3 2 0	2 8 2 0	7
8	4 0 0	9 0 0	14 0 0	19 0 0	1 4 0 0	1 9 0 0	1 14 0 0	1 19 0 0	2 4 0 0	2 9 0 0	8
9	4 2 0	9 2 0	14 2 0	19 2 0	1 4 2 0	1 9 2 0	1 14 2 0	1 19 2 0	2 4 2 0	2 9 2 0	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 4·67	0 9·34	0 14·01	0 18·68	0 23·35	1 0·02	1 4·69	1 9·36	1 14·03	1 18·70	1 23·37	2 0	

Weights of Lengths of Rolled Steel Sections.

Beam 14 in. × 6 in. × 56 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 10 0 0	5 0 0 0	7 10 0 0	10 0 0 0	12 10 0 0	15 0 0 0	17 10 0 0	20 0 0 0	22 10 0 0	0
10	0 5 0 0	2 15 0 0	5 5 0 0	7 15 0 0	10 5 0 0	12 15 0 0	15 5 0 0	17 15 0 0	20 5 0 0	22 15 0 0	10
20	0 10 0 0	3 0 0 0	5 10 0 0	8 0 0 0	10 10 0 0	13 0 0 0	15 10 0 0	18 0 0 0	20 10 0 0	23 0 0 0	20
30	0 15 0 0	3 5 0 0	5 15 0 0	8 5 0 0	10 15 0 0	13 5 0 0	15 15 0 0	18 5 0 0	20 15 0 0	23 5 0 0	30
40	1 0 0 0	3 10 0 0	6 0 0 0	8 10 0 0	11 0 0 0	13 10 0 0	16 0 0 0	18 10 0 0	21 0 0 0	23 10 0 0	40
50	1 5 0 0	3 15 0 0	6 5 0 0	8 15 0 0	11 5 0 0	13 15 0 0	16 5 0 0	18 15 0 0	21 5 0 0	23 15 0 0	50
60	1 10 0 0	4 0 0 0	6 10 0 0	9 0 0 0	11 10 0 0	14 0 0 0	16 10 0 0	19 0 0 0	21 10 0 0	24 0 0 0	60
70	1 15 0 0	4 5 0 0	6 15 0 0	9 5 0 0	11 15 0 0	14 5 0 0	16 15 0 0	19 5 0 0	21 15 0 0	24 5 0 0	70
80	2 0 0 0	4 10 0 0	7 0 0 0	9 10 0 0	12 0 0 0	14 10 0 0	17 0 0 0	19 10 0 0	22 0 0 0	24 10 0 0	80
90	2 5 0 0	4 15 0 0	7 5 0 0	9 15 0 0	12 5 0 0	14 15 0 0	17 5 0 0	19 15 0 0	22 5 0 0	24 15 0 0	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	25 0 0 0	50 0 0 0	75 0 0 0	100 0 0 0	125 0 0 0	150 0 0 0	175 0 0 0	200 0 0 0	225 0 0 0	250 0 0 0	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 60 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 1 12	10 2 24	0 16 0 8	1 1 1 20	1 6 3 4	1 12 0 16	1 17 2 0	2 2 3 12	2 8 0 24	0
1	0 2 4	5 3 16	11 1 0	0 16 2 12	1 1 3 24	1 7 1 8	1 12 2 20	1 18 0 4	2 3 1 16	2 8 3 0	1
2	1 0 8	6 1 20	11 3 4	0 17 0 16	1 2 2 0	1 7 3 12	1 13 0 24	1 18 2 8	2 3 3 20	2 9 1 4	2
3	1 2 12	6 3 24	12 1 8	0 17 2 20	1 3 0 4	1 8 1 16	1 13 3 0	1 19 0 12	2 4 1 24	2 9 3 8	3
4	2 0 16	7 2 0	12 3 12	0 18 0 24	1 3 2 8	1 8 3 20	1 14 1 4	1 19 2 16	2 5 0 0	2 10 1 12	4
5	2 2 20	8 0 4	13 1 16	0 18 3 0	1 4 0 12	1 9 1 24	1 14 3 8	2 0 0 20	2 5 2 4	2 10 3 16	5
6	3 0 24	8 2 8	13 3 20	0 19 1 4	1 4 2 16	1 10 0 0	1 15 1 12	2 0 2 24	2 6 0 8	2 11 1 20	6
7	3 3 0	9 0 12	14 1 24	0 19 3 8	1 5 0 20	1 10 2 4	1 15 3 16	2 1 1 0	2 6 2 12	2 11 3 24	7
8	4 1 4	9 2 16	15 0 0	1 0 1 12	1 5 2 24	1 11 0 8	1 16 1 20	2 1 3 4	2 7 0 16	2 12 2 0	8
9	4 3 8	10 0 20	15 2 4	1 0 3 16	1 6 1 0	1 11 2 12	1 16 3 24	2 2 1 8	2 7 2 20	2 13 0 4	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	5	10	15	20	25	1 2	1 7	1 12	1 17	1 22	1 27	2 4	

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 60 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 13 2 8	5 7 0 16	8 0 2 24	10 14 1 4	13 7 3 12	16 1 1 20	18 15 0 0	21 8 2 8	24 2 0 16	0
10	0 5 1 12	2 18 3 20	5 12 2 0	8 6 0 8	10 19 2 16	13 13 0 24	16 6 3 4	19 0 1 12	21 13 3 20	24 7 2 0	10
20	0 10 2 24	3 4 1 4	5 17 3 12	8 11 1 20	11 5 0 0	13 18 2 8	16 12 0 16	19 5 2 24	21 19 1 4	24 12 3 12	20
30	0 16 0 8	3 9 2 16	6 3 0 24	8 16 3 4	11 10 1 12	14 3 3 20	16 17 2 0	19 11 0 8	22 4 2 16	24 18 0 24	30
40	1 1 1 20	3 15 0 0	6 8 2 8	9 2 0 16	11 15 2 24	14 9 1 4	17 2 3 12	19 16 1 20	22 10 0 0	25 3 2 8	40
50	1 6 3 4	4 0 1 12	6 13 3 20	9 7 2 0	12 1 0 8	14 14 2 16	17 8 0 24	20 1 3 4	22 15 1 12	25 8 3 20	50
60	1 12 0 16	4 5 2 24	6 19 1 4	9 12 3 12	12 6 1 20	15 0 0 0	17 13 2 8	20 7 0 16	22 20 2 24	25 14 1 4	60
70	1 17 2 0	4 11 0 8	7 4 2 16	9 18 0 14	12 11 3 4	15 5 1 12	17 18 3 20	20 12 2 0	23 6 0 8	25 19 2 16	70
80	2 2 3 12	4 16 1 20	7 10 0 0	10 3 2 8	12 17 0 16	15 10 2 24	18 4 1 4	20 17 3 12	23 11 1 20	26 5 0 0	80
90	2 8 0 24	5 1 3 4	7 15 1 12	10 8 3 20	13 2 2 0	15 16 0 8	18 9 2 16	21 3 0 24	23 16 3 4	26 10 1 12	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	26 15 2 24	53 11 1 20	93 7 0 16	117 2 3 12	143 18 2 8	170 14 1 4	197 10 0 0	224 5 2 24	251 1 1 20	277 17 0 16	

Compiled and Arranged by T. E. Woodhouse.

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MODERN STEAM TURBINES.

By J. Humphrey.

(*Continued from page 93.*)

For some years the high speed of the steam turbine was in many cases a distinct disadvantage, as for example, in connection with the propulsion of ships, and in consequence of the inability of engineers to make gears for giving a suitable speed reduction, and at the same time capable of transmitting the high powers involved, the application of the steam turbine was somewhat limited. In the early days of the industry, the turbine was used almost exculsively for driving high-speed electric generators and blowers. Highly efficient and otherwise satisfactory gears have, however, now been available for a considerable time, and it is common knowledge that the turbine is now used for many purposes involving a more or low speed drive. The use of high-speed gears in connection with marine work permits a high speed and, consequently, light turbines to be used, whilst at the same time the propeller speed need not exceed the economical value. Turbine gearing has also proved of great value in connection with the operation of direct current electric generators. Owing to the commutation difficulties which arise in connection with high-speed D.C. electric generators, the production of direct-coupled turbo-generators of this sort has not been at all easy.

Many high-speed D.C. generators have certainly been designed and constructed, but the tendency for some time past has been to use geared generators, and several well-known firms, including Messrs C. A. Parsons, are now adopting this plan. The generator can, of course, be designed for the best and most economical speed, and all difficulties in connection with commutation are eliminated.

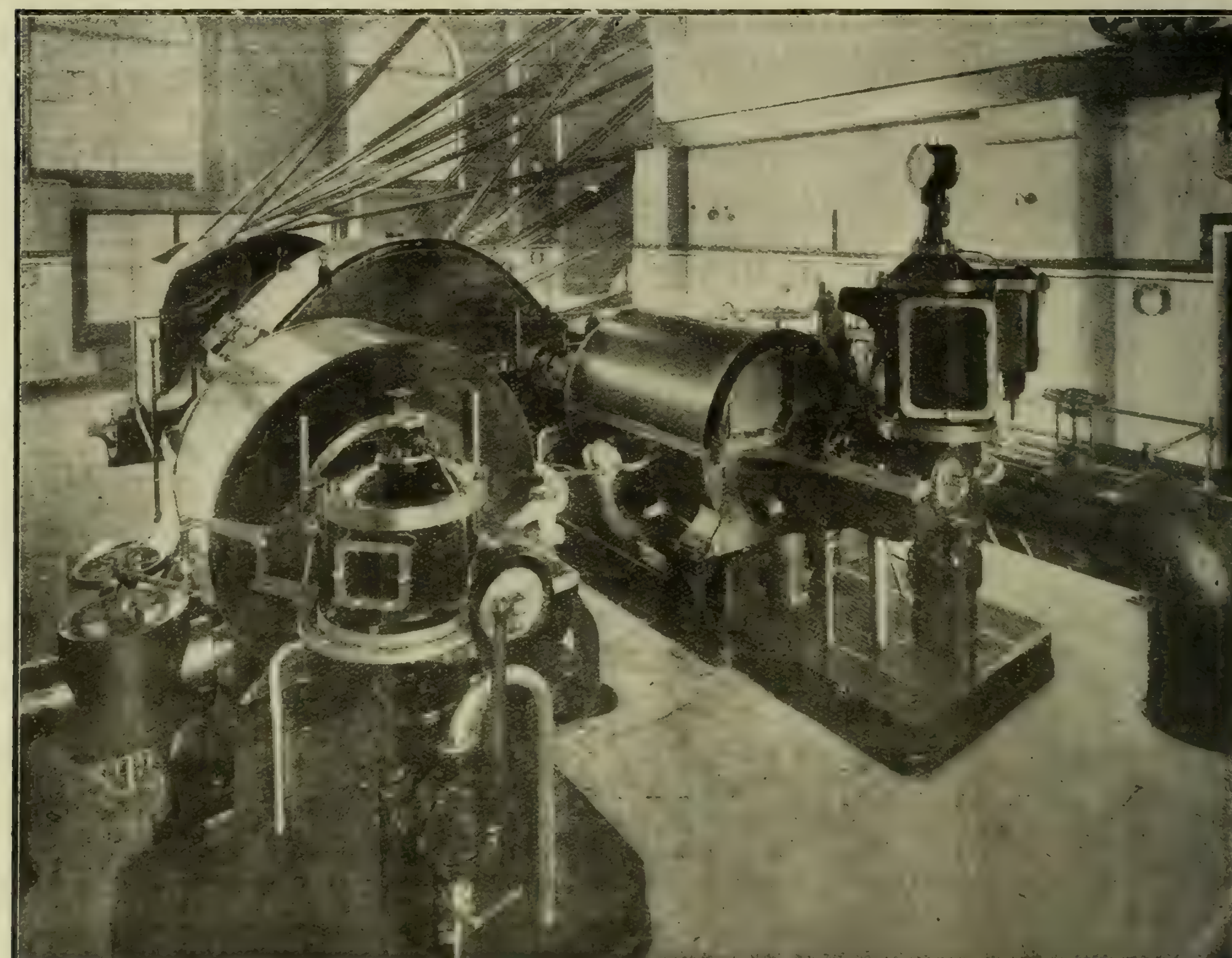


Fig. 100.
A Parsons' Geared Turbine Driving a Textile Mill.

Geared turbines are also being used with marked success for textile mill driving. For work of this kind a steady drive is, of course, essential, and owing to the absence of reciprocating parts a turbine is ideal. In many instances a geared turbine has been adapted to cases where the existing engine was old and uneconomical, and where it was found possible to instal a turbine and a rope pulley close to the existing engine. In this way it has been possible to

change over a mill from a reciprocating engine drive to a turbine drive in the course of a week-end, or even during a single night, since all that is necessary in such cases is to shift the ropes from the pulley of the reciprocating engine to the pulley of the turbine. Another desirable feature of the turbine, from the point of view of textile mill driving, is that it is capable of exerting a good starting torque. All the machinery in a textile mill can consequently be started quite easily against the Monday morning friction load. When the turbine was first introduced into textile mills, it was thought that it might be necessary to fit a small barring engine in order to facilitate the pulling on and overhauling of ropes, but it was found from practical experience that nothing of this kind was required. Not only can the ropes be put on by running turbines under their own steam, but the entire driving equipment can be "inched" round for rope inspection, etc., simply by manipulating the stop valve.

A Parsons' geared turbine has now been in successful operation in one of Messrs. Kershaw, Leese and Co's. India cotton spinning mills, Stockport, for a considerable period. The mill is an eight storey building, 110 feet high, in which ring and mule spinning and the requisite preparatory processes are carried on. Originally the mill was driven by means of a large four-cylinder beam engine, working at a pressure of 110 lb. per square inch. This engine drove a large fly-wheel geared with two pinions mounted on heavy shafts, each pinion driving a vertical shaft, reaching to the top of the mill. The vertical shaft carried bevel gears for the purpose of driving the line shafts running the full length of the mill, there being two of these shafts in each storey. Owing to the length of time during which the old engine and gearing had been at work, serious defects were rapidly developing which necessitated the old plant being scrapped. All the possible substitutes for the original equipment were considered, and the final conclusion arrived at was that a geared turbine would give the best results. From the point of view of coal consumption, the turbine showed up to better advantage than a reciprocating engine working at the existing steam pressure of 120 lb. per square inch, or even if the pressure had been raised to 180 lb. As the existing boilers were in good condition, it was decided to retain them and to work the turbine at the original pressure, and tests have shown that the saving in steam consumption, as the result of the installation of the turbine, amounts to 35 per cent. Another reason for installing the turbine was that it enabled the change over to be made in a short space of time. Further, by installing a geared turbine, it was possible greatly to minimise the size of the new engine room, thus avoiding crippling the space in the mill. In these three important aspects, *i.e.*, economy in coal consumption, small floor space and minimum interference with the working of a mill during the time in which the change over is being made, the geared turbine offers important advantages over other methods of driving, and when to these advantages are added the reliability, extereme steadiness of running, low cost of operation and the steady maintenance of economy after years of operation, the suitability of the geared turbine for mill driving will readily be recognised. The low-speed shaft running at 250 R.P.M. is directly-coupled to the shaft carrying the main rope pulley, which is 6 ft. 4 in. in diameter, and is grooved for 44 $1\frac{3}{4}$-in. ropes. This rope drive is rather a remarkable one. There are thirteen line shafts in eight rooms, and these were extended through the end wall of the mill across the old engine house and into a new rope race built in the yard. Six of these shafts are directly-driven by ropes from the main rope pulley on the turbine. Where there are two line shafts in one room, a parallel counter rope drive is provided. It was found convenient to drive the sixth storey from No. 4, whilst the intervention of masonry necessitated the bottom storey being driven from No. 2. The pedestals carrying the extensions to the line shaft are mounted on strong cast-iron beams with cross beams, the pedestals being of the ring oiling type. Gangways with ladders and hand railing are provided in the rope race for access to all the moving parts.

The condenser auxiliaries, *i.e.*, the air and circulating pumps are driven by a special group of six 1-in. ropes from a pulley mounted on the coupling which secures the gear wheel shaft to the main driving shaft, but in order that the plant may have the benefit of full vacuum for starting, a small auxiliary steam enine is provided which, by means of a pair of friction clutches, can be used to start up the condensing plant a few minutes before the main turbine is started. When the turbine has been run up to speed, however, the movement of a hand-wheel alters the clutches, and the auxiliary engine can then be shut down. A view of the turbine, which has high and low pressure cylinders, is shown in Fig. 100, the gearing which reduces the turbine speed from 3,500 to 250 R.P.M. being shown in the background. The whole of the millwright's work in connection with the India mills installation was carried out by Messrs. Scott and Hodgson Ltd., of Guide Bridge Iron Works, near Manchester.

(*To be continued.*)

THE CAUSES OF GRINDING WHEEL BREAKAGE.*

By Harold E. Jenks.

The subject of grinding wheel breakage is one which directly concerns every wheel consumer as well as the manufacturer of the product.

Breakage of the wheel affects the consumer, since it means danger to the operator and possibly to others in the shop. It also involves considerable expense, due to the loss of the wheel itself and loss of time in procuring and mounting another one.

It affects the wheel manufacturer, since it is obviously for his interets to have as few breakages as possible charged up against his wheels, and since, if the cause of breakage is clearly due to manufacturing defects, he will be expected to replace the broken wheel at his own expense.

It is important, then, that wheel breakage should be reduced to a minimum. To do this, its underlying causes should be clearly understood, and it is with the purpose of making these causes clear that this article has been written.

Breakage of a grinding wheel while in operation

* *Grits and Grinds.*

may be due to any one of the following causes, or to a combination of two or more of them:

1. Centrifugal force due to rotation of the wheel.
2. Direct pressure exerted by the work on the wheel.
3. Heating of the wheel or spindle.
4. Grinding on the side of the wheel (side pressure).
5. Improper mounting.
6. Impact on the side or face of the wheel.
7. Cracks or flaws in the wheel structure.
8. Lack of balance.
9. Initial stresses.

It is unavoidable that these causes should overlap to some extent; for instance, heating of the wheel is a result of direct pressure by the work. It is thought, however, that the list has been condensed as much as possible to still retain the desirable property of clearness.

By "stress," as used here, is meant force acting between the particles of wheel material per unit of area—let us say in pounds per square inch. Wheel material is much weaker under tensile stress than under compressive stress—that is, a much smaller force will break it if tending to pull its particles apart than if tending to push them together. For this reason, stresses are herein specified as tensile or compressive, it being understood that compressive stresses are not important as sources of breakage. Mathematical proof of statements made regarding the amount and position of stresses in wheels is beyond the scope of this article and is therefore omitted.

Much importance should be attached to the fact that although not one of the existing stresses in a wheel may be excessive, the combination or resultant of two or more of them may be sufficient to cause breakage.

(1) *Centrifugal Force Due to Rotation of the Wheel.*—In any body which rotates about an axis, stresses are induced at every point due to centrifugal force, which is the force tending to make the body fly apart. In a grinding wheel these stresses are of two kinds: a radial stress acting in the direction of the radius of the wheel; and a tangential stress acting in a direction perpendicular to the radius. Both these stresses are tensile. The tangential stress is much the larger of the two, and reaches its greatest value at the inside of the wheel—that is, around the circumference of the hole.

The radial stress has its maximum at a point from one third to three-fourths the distance from the face of the wheel to the hole. The amounts of both stresses vary as the square of the wheel speed, which means that if the speed is doubled the stresses are quadrupled. For a given peripheral speed and diameter of wheel, the maximum tangential stress increases slightly as the diameter of the hole is made larger, and in cylinder wheels becomes about twenty per cent greater than in disc wheels with ordinary sized holes.

Since a grinding wheel in operation is always revolving, stresses due to centrifugal force always exist: and although it is probable that comparatively few wheels in operation break from these stresses alone, others may easily combine with them and produce breakage.

Reliable grinding wheel manufacturers test all wheels before they leave the factory, by running them at such speeds that the minimum safety factor is 2½ and the maximum in some cases as high as 5. As a result of this precaution, practically all breakages that occur from centrifugal force alone, can be traced to such causes as shifting thoughtlessly from large to small pulleys, placing large wheels on spindles running at speeds intended for small ones, or substituting for a wheel running at the correct speed one of different grain and grade and lower recommended wheel speed. In other words, these breakages are nearly all due to carelessness or ignorance on the part of the operator.

(2) *Direct Pressure Exerted by the Work on the Wheel.*—By "direct pressure" is meant pressure on the face of a wheel directed toward its centre. Stresses produced by this pressure are of two kinds—radial and tangential or frictional.

The radial stress is the same as would be produced by direct pressure, if the wheel were not revolving, and is compressive. It is usually small in amount and is unimportant as a cause of breakage.

Contact between the particles of the revolving wheel and the work, produces a frictional force whose amount is proportional to the direct pressure and which is in the direction of a tangent to the wheel face. This force causes bending stresses along a diametrical section of the wheel which are tensile on one side of the centre and compressive on the other. These stresses reach their largest value at the face of the wheel, and are usually small and unimportant.

(3) *Heating of the Wheel or Spindle.*—Considerable heat is developed at the point of contact of wheel and work, and in cases where grinding is done dry the wheel may become very hot. The stresses produced by unequal expansion of different parts of the wheel may in this case reach a large value, and many breakages are probably due to this cause. These stresses are similiar to those resulting from centrifugal force, and are (as in that case) of two kinds—readial and tangential. They may vary greatly in amount according to variations in temperature of the wheel, and an exact determination of their amount is difficult, if not impossible. The greatest tensile stress occurs around the circumferance of the hole, and hence combines with the greatest stress due to centrifugal force.

Heating of the spindle may be produced by tight bearings on the machine; and if the wheel bushing fits the spindle tightly, expansion of the latter will cause tensile stresses of considerable magnitude in the wheel, which, added to the maximum stress due to centrifugal force, may cause breakage.

(4) *Grinding on the Side of the Wheel (Side Pressure).*—Many breakages are directly caused by side pressure, which occurs to a limited extent when work is being traversed across the face of the wheel, but principally when grinding is done on its side. Also, particularly in snagging operations, large side pressure may be produced by grinding on or "working" the corners of the wheel face. The effect of side pressure is to produce a bending stress whose maximum reaches all points of the wheel as it revolves, and which is tensile on the side of the wheel which sustains the pressure and compressive on the other.

Properly designed flanges used on wheels of sufficient thickness are the best protection against breakage due to side pressure. They not only greatly reduce the maximum stress due to this pressure, but prevent its attaining its maximum at the circumference of the hole, where it would otherwise combine with the maximum due to centrifugal force.

(5) *Improper Mounting.*—This subject is of such importance to all grinding wheel users that it is thought advisable to first give the following brief statement of the essentials of correct mounting:

Care should be taken that the sides of the wheel and the sides of the flanges in contact with the wheel are plane surfaces, in order that an even bearing may be secured.

The hole should be of a diameter approximately ·005 in. larger than the spindle or arbor on which the wheel is to be mounted, and must be at right angles to the sides of the wheel, concentric with the circumference. No portion of the bushing should project beyond the sides of the wheel.

The spindle should be perfectly straight and threaded in a direction such that any tendency for the wheel and nut to turn will tighten the nut.

Flanges are used primarily to transmit power from the shaft to the wheel, and for this reason the inside flange must be keyed to the shaft. Both flanges must have plane faces at right angles to the shaft, and should be properly relieved—that is, they should be countersunk so as to bear on the wheel only on the part of the side of the flange nearest the rim.

Blotters or some other form of compressible washers should be used between flange and wheel to insure an even bearing. Their diameter should be at least as large as that of the flanges.

The nut should be tightened only enough to properly hold the wheel. Further tightening is unnecessary and undesirable.

Stresses in the wheel due to improper mounting are particularly important because they all combine directly with the maximum due to centrifugal force.

Forcing a wheel on a spindle for which its hole is too small is extremedy likely to result in breakage, as large tensile stresses are induced around the circumference of the hole. If the hole is too small, it should be carefully enlarged by scraping until a perfect fit is obtained.

Side pressure producing large tensile stresses may result from any defect in mounting, which tends to produce uneven bearing between flanges and wheel, such as bent or broken flanges; projecting bushings; high spots on bearing surfaces of flanges or wheel; flanges not properly relieved; failure to use proper compressible washers; flanges of different diameters, or excessive tightening of the spindle nut.

(6) *Impact on the Side or Face of the Wheel.*—Probably most breakages due to impact are the result of carelessness or ignorance on the part of the operator. It should be borne in mind that stresses in a wheel produced by a suddenly applied force are very much larger than those produced by the same force if applied gradually.

The impact of the particles of the wheel on the work in any form of grinding produces certain stresses in the wheel, but these are carried more by the particles in direct contact with the work than by the wheel as a whole, and are not important as a cause of breakage. Cases have been known, however, where ignorant operators, in order to increase the speed of cutting, have hacked the face of the wheel in such a manner as to cause breakage due to this form of impact.

Breakages are sometimes caused by bringing heavy pieces of work into too sudden contact with either the face or side of the wheel. Carelessness in snagging castings suspended from chain hoists, for example, might easily produce breakage of this kind.

In work requiring a table reverse, the headstock or footstock may be run into the wheel, which will cause wheel breakage unless something else gives way first. This is not true impact, but approaches it on account of the suddenness of application of the force, and results in large stresses due to side pressure.

Catching of the work between the wheel and the rest in free hand operations is very likely to cause wheel breakage. Such an accident may be due to improper adjustment of the rest, or to lack of attention or ignorance on the part of the operator, and may have very serious consequences. This is a true case of impact, the speed of application of the force being practically the speed of the periphery of the wheel.

(7) *Cracks or Flaws in the Wheel Structure.*—Wheel breakage sometimes occurs because of cracks or flaws which are in the wheel before it is put in operation. Such defects may be entirely under the surface of the wheel and therefore not visible. Flaws are manufacturing defects, while cracks may be due to faulty manufacture or to various other causes, such as carelessness in transportation, handling, unpacking, or storage.

Due to the fact that the Norton Co. uses such extreme care in testing wheels for flaws and cracks, it is practically impossible for a wheel with such defects to pass inspection and be shipped outside the factory.

The "ring" of a wheel, or sound produced by its vibration when tapped lightly with some solid object, is used as one indication of interior cracks or flaws. A wheel with a clear "ring" is fairly certain to be free from such defects, although it has been shown that a poor "ring" does not necessarily mean a defective wheel. Norton Co., however, in order to be on the safe side, rejects all wheels which do not ring clear.

After the test by "ringing" the wheel, all wheels of over 5 in. in diameter are given a speed test at about double the recommended operating speed, as stated previously. This is a very severe test and is practically certain to eliminate defective wheels.

Rigid inspection follows this speed test, and the wheels are very carefully packed for shipping in strong boxes made especially for the purpose.

Breakages due to cracks are therefore beyond the control of the Norton Co., since these cracks must occur subsequent to the time the wheels are shipped.

(8) *Lack of Balance.*—A wheel that is out of balance has developed in it stresses of rather complex character. In cases where the lack of balance is very great, breakage may result, either from these stresses or from impact, as will appear below. Lack of balance may be due to several causes whose description follows:

Variations in density in a wheel may cause imperfect balance. However, this can hardly prove

serious in the case of wheels furnished by any reliable grinding wheel manufacturer, as the homogeneity of structure of such wheels precludes the possibility of a dangerous amount of lack of balance.

If a wheel goes out of true for any reason, it will also go out of balance, since its certre of rotation will no longer be at its centre of gravity. Wheels may go out of true from such causes as a bent spindle, loose bearings, loose frame, improper use, or from the backing of the wheel face previously mentioned. If a wheel is seriously out of true, it will deliver a series of blows to work thrust against it, thus producing large impact stresses. The stresses due to the centrifugal force of the out of balance portions of the wheel may also become large in this case and will combine with the maximum due to centrifugal force.

A wheel should not be allowed to stand partially submerged in water or other liquid, for when it is started in motion the wet portion is much heavier than any other, and hence the wheel is greatly out of balance. Several cases of breakage from this cause are known.

(9) *Initial Stresses.*—During the process of manufacture of any solid body, initial stresses are sometimes set up in the material of which the body is composed. Unless great care is used in its manufacture, a grinding wheel may have such stresses existing in it. These may be regarded as incipient flaws or cracks, and may combine with other stresses to increase the maximum stress in the wheel. No method has yet been devised for determining the existence of initial stresses in wheels. However, Norton Co. by the speed test mentioned above eliminates from its finished product all wheels with large initial stresses. By running all wheels at double the recommended operating speed, and thus quadrupling the stress due to centrifugal force, any wheels having extraordinary initial stresses are broken.

On account of the number and variety of the possible causes of wheel breakage given above, it is easily seen that the actual determination of the real cause of breakage of a single wheel may be difficult or impossible. In cases, however, where breakages occur consistently with a certain operator or on a certain machine or operation, it may be reasonably assumed that there are one or two principal causes involved which can by a study of the situation be detected and removed.

A conservative statement, based on experiments, investigation, and long experience with wheel breakages, is that practically all breakages are due to causes beyond the control of the grinding wheel manufacturer, and may in no way be attributed to weakness in wheel structure.

Canada and Wooden Houses. A striking commentary on what Dr. Addison describes as "the stunt Press" campaign for wooden houses in this country comes from Canada in a letter just received by Winget Limited from an industrial engineer in Ottawa, who is about to build houses of concrete blocks, in place of the Canadian wooden houses, of which we have recently heard so much. "It may seem strange to you," he writes, "in view of the present agitation in England for the construction of wood houses, that we, in Canada, should be considering the construction of concrete houses, but so it is; the high insurance now charged here for the insurance of wood houses, the high cost of painting and repairs, also the high cost of wages paid for carpenters (three times the cost before the war), compels us to find some means by which houses can be erected, with the minimum expenditure for labour, insurance, and repairs."

JIGS, TOOLS, AND SPECIAL MACHINES, WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By Herbert C. Armitage, of Birmingham, Associate Member.

(*Continued from page 103.*)

Continuous Drill Both Ends of Connecting-Rod (Fig. 14).

This figure shows in outline a four-spindle drilling machine, and no pretence is made that the machine is proportioned correctly. Upon the table there are four pairs of connecting rods. The saddle feeds down to drill the holes, the cut is automatically released, then it traverses upwards quickly to clear the work. In the meantime, the table indexes round a quarter of a turn, and two more rods are brought into position for drilling. The saddle again feeds downwards, and by this cycle of operations continuous drilling is very economically obtained. It should be quite possible for one man to mind two or even three machines of this type, and this is where

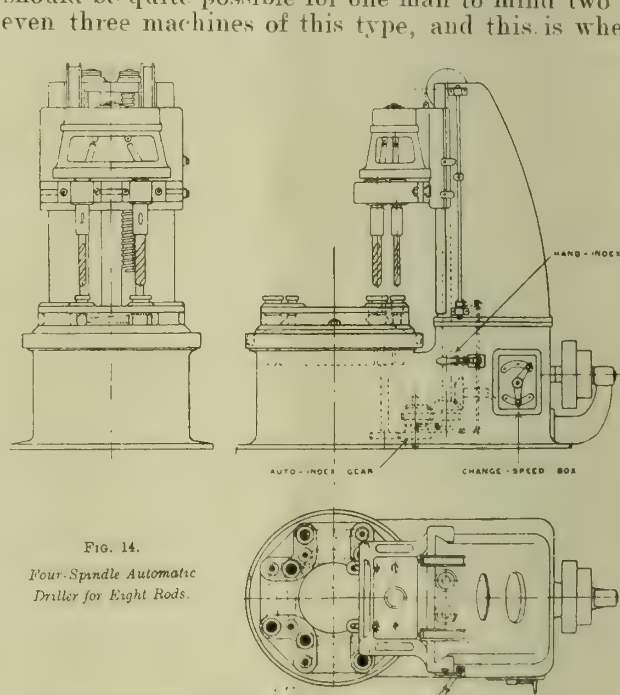


Fig. 14.
Four-Spindle Automatic Driller for Eight Rods.

Jigs, Tools, etc Fig. 14.

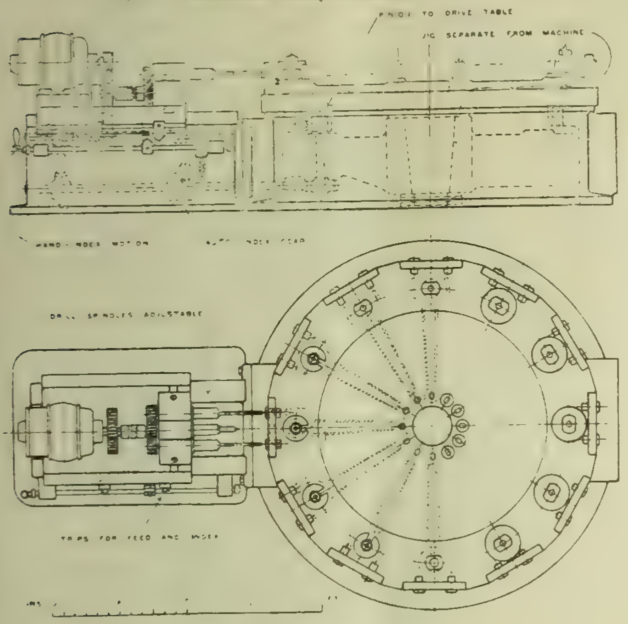
the real economy of highly specialised machine tools comes in, otherwise there are few advantages worth mention It is worth noting that a machine of this type can be used for any number of similar jobs, and should therefore not be any loss or even stand idle in a manufacturing works which has connecting rods of any description to make. It is very surprising indeed to notice that few of the larger type of machine tools automatically index the work into position. Possibly a really first-class and powerful index mechanism has to be designed, although the principle is fairly well established in automatic screw machines and gear cutters.

Continuous Drill Bolt-Holes and Centre-Rods (Fig. 15).

This machine is practically identical in principle with the one previously described, except that the

spindles are horizontal. The indexing will be for a larger number of rods, and the spindles, saddles, and index motion are driven by means of an electric motor. In practice it will be found very likely that another head can be placed upon the other side of the machine, thereby getting double the output. It

Fig. 15.—*Continuous Drilling Machine for Bolt-Holes.*



Jigs, Tools, etc.—Fig. 15.

would be necessary, however, to drive the drills in the saddle from the same motor.

Continuous Mill Sides of Rod (Fig. 16).

In this machine, of which a plan only is shown in the drawing, there are two substantial face-milling heads. The connecting-rods are arranged radially on a circular frame, which is driven round at the correct feeding speed. The whole machine is driven by an electric motor, and the rods are loaded in on the opposite side of the

Fig. 16.—*Continuous Milling Machine for Sides of Connecting-Rod.*

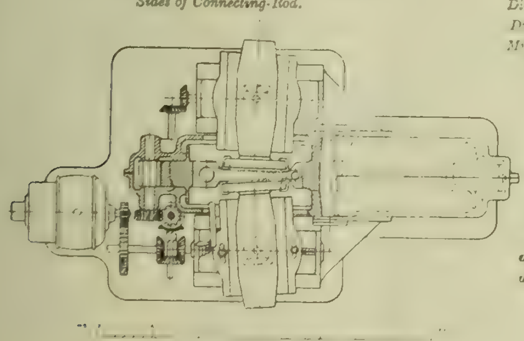


Fig. 17.—*Diagram showing Duplex Vertical Miller for Facing Bolt-Holes.*

Jigs, Tools, etc.—Figs. 16 and 17.

machine whilst revolving. There is a doubtful economy, however, in continuous milling of this description, as the rods would have to be spaced some considerable distance apart. For instance, if the metal between them is only $1\frac{1}{4}$ inches and the rods themselves are $\frac{3}{4}$ in. wide, it means that a cut has to be taken over two inches in order to mill $\frac{3}{4}$ in. Supposing that the rate of feed is one inch per minute, it will be seen that the effective continuous milling feed obtained is only $\frac{3}{8}$ in. per minute. This is true of any continuous milling operation, and it is doubtful whether the application shown is worth the results obtained. In this machine some support would have to be given to the middle of the connecting-rod to prevent excessive chattering. Compressed-air operated clamps and jig stops will prove very useful in this respect, and will greatly reduce the time in fixing the work.

Milling Across Bolt-Hole Bosses and Faces.

It is practically impossible to "continuous mill" across the top of the bolt holes, except by a profiling motion, and which will necessitate a complicated machine. For milling the sides of the bolt faces, a dupex vertical spindle milling machine would be very effective, and almost continuous milling action could be obtained with very little trouble. The diagram of this is shown in Fig. 17. It is strange why this type of machine is not more popular, as it undoubtedly has a very wide field of usefulness for any description of rods, or repetition work which requires milling at both ends.

Finish Boring on Special Machines.

There is little to be gained by building a special machine-tool for finishing boring the large end, and up to the present date nothing better than the turret lathe has been found. So far as the author knows, there has been no effective method yet devised for obtaining accurate continuous boring action, because this can only be obtained by revolving the tool. It is the universal practice to revolve the work where its size permits, and feed the tool. If it were possible to obtain accurate results by means of a revolving cutting tool, combined with a turret, continuous action would be easily obtainable.

(*To be continued.*)

CONSUMPTION FIGURES IN THE BRASS-FOUNDRY.

Some rather valuable figures have recently been obtained from a Continental source by Messrs. Alldays and Onions Ltd., Great Western Works, Birmingham, the makers of the Charlier rolling furnace, respecting consumptions and melting losses of this type. These figures have been selected by the well-known French metallurgist, Monsieur G. Espagne, from the results of the many tests he has carried out. Though these figures in certain cases appear to be contradictory, any information which throws further light on the subject of melting costs will probably be welcomed in the progressive foundry.

For the benefit of those who are not acquainted with the type, it may be explained that the Charlier furnace is of drum-shaped construction, lined with suitable refractory and mounted on trunnions. It is suitable for either oil or gas firing, and the burner is arranged to play through one of the trunnions direct into the melting chamber. No crucibles whatever are employed, and the pour is effected by tilting.

The first set of figures are the results of tests carried out at an establishment in Hayange (Alsace), "Les Petits Fils de Francois Wendel et Cie":—

Number of Melt	1	2	3
Metal	Gunmetal	Gunmetal	Gunmetal Swarf.
Weight of Charge	706 lbs.	706 lbs	353 lbs.
Time	57 min	38 min	28 min.
Consumption	9 46 gal.	8·36 gal.	3·74 gal.
Consumption Melting Ratio	13·4 %	11·87 %	10·6

The question of melting losses is a point which is frequently raised in discussing any performance of the Charlier furnace, in view of the fact that no crucible is employed. The following two tests, which were carried out in the foundry of a large French railway works, have a direct bearing on this point:—

First: Gunmetal.

Theoretical Composition.

Copper	82
Tin	15
Zinc	3

Analysis of the Metal Poured.

Copper	81·410
Tin	15·357
Zinc	3·062
Lead	0·171

Charged in Furnace

Old Copper	541 lbs
Tin	99 lbs.
Zinc	20 lbs.
Metal poured	645 lbs.
Melting loss	2⅓%

Second: Gunmetal.

Theoretical Composition.

Copper	87
Tin	10
Zinc	3

Analysis of Metal Poured.

Copper	87
Tin	10·097
Zinc	2·775
Lead	0·128

Charged in Furnace.

Old Copper	574 lbs.
Tin	66 lbs.
Zinc	20 lbs.
Metal poured	647 lbs.
Melting loss	2%

(Note.—The excess of Sn and Pb in the metal poured resulted from the zinc scrap employed, which contained a certain amount of solder.)

On the other hand the makers of the Charlier furnace point out that it is neither in the interests of foundry nor furnace builder to affirm that melting losses in the Charlier are invaribly as low as the figures above quoted.

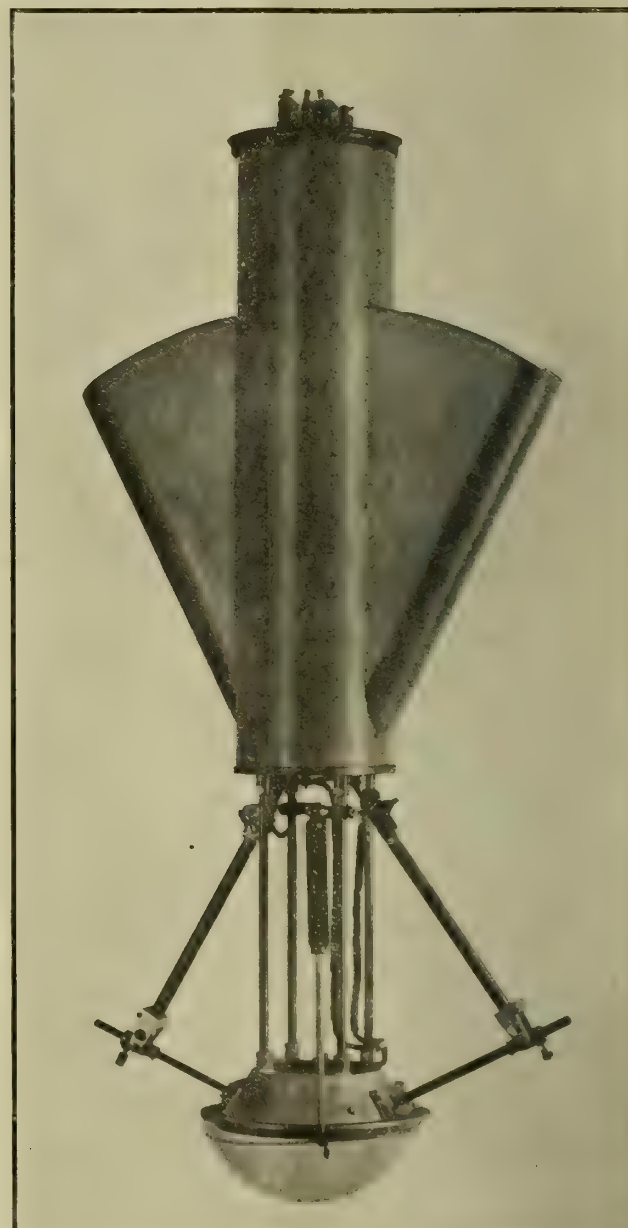
This point is well illustrated by Monsieur Espagne, in the case of some further tests carried out in a foundry in the Haute-Saone.

The foundry in question specialise in the production of ornamental work known as Parisien bronze.

Old metal had to be melted containing Cu 65 per cent and Zn 35 per cent, and similar tests were carried out in an ordinary crucible furnace of the natural draught type, working side by side with the Charlier, upon precisely the same material and under precisely similar conditions. The results are quoted below:—

Type of Furnace	Crucible	Charlier	Charlier.
Metal	Swarf	Swarf	Swarf.
Weight of Charge	220 lbs.	440 lbs.	660 lbs.
Weight of Pour	209 lbs.	418 lbs.	623 lbs
Melting Loss	5 %	5 %	5·6 %.

Though the tests above quoted appear slightly contradictory, they are sufficient to prove that when a Charlier furnace is worked with a certain amount of care the melting losses, even in brass, is very far from being abnormal, in addition to which the Charlier furnace effects considerable economies through the elimination of expensive crucibles, and considerable reduction in labour charges on account of its large production.



A New Arc Lamp. The accompanying illustration shows a novel form of arc lamp which has been designed principally for film studio and photographic purposes. The special feature in this lamp is a horizontal arc with uninterrupted illumination on the underside. The lamp is now on show at the head office of the makers, Messrs. B. J. Hall and Co. Ltd., Chalfont House, Great Peter Street, London, S.W., who are anxious for all interested to come and inspect and make tests. The designing and building of the lamp has been carried out entirely at their own works, and a patent has been applied for.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(Continued from Vol. VII., page 463.

Heating of Horizontal Wires.

The heating of nichrome wire when suspended in a straight horizontal line in free air has been the subject of an extensive series of experiments at the Lewis Institute, Chicago, and tables have been compiled for round wire of Nos. 1 to 33 B. and S. inclusive, and also for various sizes of flattened wires or ribbons. The following figures relate to No. 20 round wire, the temperature of the air being 20° C.:—

Temperature of wire above air, °C.	Amperes.	Length in feet with 110 volts at end.
50	1.53	114
100	2.43	69.2
150	3.05	53.7
200	3.57	45
300	4.80	32
400	5.78	26
500	7.00	21.1
600	8.00	18.3
700	9.40	15.4
800	10.80	13.3
900	12.30	11.6
1000	13.80	10.3
1100	15.30	9.3

The resistance R of the wire per foot length will be given by dividing the 110 volts by the current C and the length of the wire L in feet, or

$$R = \frac{110}{CL}.$$

From this formula the resistance per foot can be deduced for each of the temperatures. The values obtained are given in the next table:—

Temperature of wire. °C.	Resistance per foot. Ohms.
70	0.6306
120	.6542
170	.6716
220	.6907
320	.7163
420	.7318
520	.7447
620	.7513
720	.7902
820	.7658
920	.7709
1020	.7739
1120	.7731

These figures show that there is an increase of resistance to 720° and afterwards the resistance falls and does not change much up to 1,120°.

The effect of increasing the size of the wire on the carrying capacity for various temperatures is exemplified by the next table:—

No. B. & S.	Temperature of wire above air, ° C. 50	100	500	1000
	Carrying capacity in Amperes.			
1	33	53	154	319
4	20	32	94.5	191
7	11.8	19	56.6	116.2
10	7	11.3	34.4	70.5
13	4.4	7	21.1	42.8
16	2.8	4.4	13.1	26.3
19	1.7	2.7	8.2	16.2
22	1.1	1.75	5.1	10.05
25	0.69	1.11	3.21	6.25
28	0.47	0.74	2.06	3.97
31	0.30	0.47	1.38	2.52

An examination of the above table leads to the interesting conclusion that the carrying capacity of a wire for 50° C. is approximately equal to that at 100° C. for a wire three gauge numbers higher in the list. Thus, for No. 16 at 50° the current is 2.8 amperes, whilst for No. 19 at 100° it is 2.7 amperes. On the other hand, for temperatures 500° and 1,000° C., the higher value requires nearly a double current for the same gauge number. For example, No. 16 requires for 500° a current of 13.1 amperes, but to raise it to 1,000° C. above the air temperature 26.3 amperes are required.

Radiant Efficiency.

A heated body loses heat by thermal conduction to its supports, by convection currents of heated air, and by radiation through the air space. In the case of domestic heating appliances like the coal fire, the gas fire, and the electric radiator, the most satisfactory way of heating the human body is furnished by radiant heat, and it is therefore of considerable importance to design such heaters so as to secure as large a percentage as possible of direct radiant energy. The tabulation, with any degree of exactness, of the respective percentages of conduction, convection and radiation is a problem of considerable difficulty. The simplest case is the electrically-heated horizontal wire. Here, except at a little distance from the supports, the loss of heat by conduction along the wire may be neglected, and it remains only to deal with convection and radiation. As compared with the former, the direct experimental measurement of radiation is a relatively easy problem. The percentage of radiation having been ascertained, it is only necessary to subtract this value from 100 to obtain the convective heating.

Radiation.

Light and radiant energy, according to the adopted views of science, are wave motions in the ether, which is supposed to occupy all space. The short waves which affect the eye constitute light energy, whilst the long waves are heat waves. The study of these energies are included under a distinct subject called *radiation*. When a body is gradually heated, electrically or in other ways, at low temperatures, it radiates heat waves, but when it becomes luminous it emits both light and heat waves. As the temperature is raised the relative number of the short waves increase. At very high temperatures, such as that of the electric arc, exceedingly short waves are emitted unable to produce the sensation of light, but which can give photographic effects.

If radiant energy falls upon any opaque surface, some of the waves are reflected and other are absorbed, causing the surface to be raised in temperature. If the surface is dull black a small percentage only of the incident energy is reflected, whereas if it be light in colour and highly polished, like burnished silver, relatively few waves are absorbed. Experiments show that the nature of the surface also affects the rate at which heat and light are emitted from a body that is heated. This may be illustrated in many ways. Thus, if on a piece of bright platinum foil a dark mark be made, when the foil is heated in a bunsen flame the blackened part will appear much brighter than the equally heated polished metal surface, for the reason that the dark part is a better radiator. Generally the state-

ment may be made that good absorbers are good radiators, and good reflectors are bad radiators. In order to compare the radiating powers of various surfaces it is convenient to adopt as a standard an absolutely black body able to absorb 100 per cent of the radiation falling upon it. No actual surface has this property, but one covered with lampblack approaches this condition, and by a simple device all the conditions of an absolutely black body can be readily realised. This consists of a hollow chamber with a small opening. Let the chamber be heated (most conveniently electrically), and by suitably placed screens with openings opposite the aperture in the chamber, allow only the radiation from the interior of the chamber to pass forwards. This radiant energy will be such as if it issued from an absolutely black body. Suppose that the real radiating power of the inside of the chamber is 90 per cent of a perfect radiator, then the radiation that passes out will be increased by 10 per cent, which represents the heat from the walls of the chamber that is reflected. We thus get the 100 per cent of radiant energy.

The Law of Stefan.

If a body A at the absolute temperature T_1 be near a body B at the lower absolute temperature T, then both A and B emit radiant energy, but A loses more than it receives from B. The actual loss of energy E per second per square cm. of A depends on the law of Stefan:—

$$E = k\,(T_1^4 - T^4)$$

where k is a constant which for a perfectly black body is about $1{\cdot}3 \times 10^{-12}$ calories. This law shows that the radiation rises very rapidly with temperature.

EXAMPLE 1.—A body at 327° C. is raised to 627° C., the air temperature being kept at 27° C., find the increase in radiant energy.

ANSWER.—The corresponding absolute temperatures are obtained by adding 273, and become 600, 900, and 300, hence the relative radiations are:—

$$\frac{900^4 - 300^4}{600^4 - 300^4} =$$

$$\frac{(900 + 300)\,(900 - 300)\,(900^2 + 300^2)}{(600 + 300)\,(600 - 300)\,(600^2 + 300^2)} =$$

$$\frac{1200 \times 600 \times 900{,}000}{900 \times 300 \times 450{,}000} = 5\tfrac{1}{3}.$$

It must be noted that Stefan's law relates only to radiation and not to convection and conduction, which cause loss of heat more in proportion to the excess of temperature above the surroundings, whilst radiation increases rapidly with the temperature, and at high temperatures controls almost entirely the loss of heat.

(To be continued.)

Trade Items, Notes, &c.

TARGA FLORIO RACE.—We understand that of the 21 cars running in the above event 16 were lubricated with Gargoyle mobiloils, and that three of the first four successful competitors used these popular lubricants.

10,000 MILES BENZOLE TEST.—In the official report of the 10,000 miles road test of benzole, conducted by the Automobile Association, there are a few interesting remarks concerning lubrication. The oil used, the experts write, was vacuum A, which gave complete satisfaction, the amount burned being five gallons three quarts, or 1,739 miles per gallon. No physical effects of any sort rising from the use of benzole were observable throughout the motor in the lubricating properties of the oil. This official testimony is as convincing as one could desire, and shows that when Gargoyle mobiloils are used—there are five grades suitable—there is no difference as compared with petrol; possibly it may also encourage the extended use of petrol.

HOUSING PROBLEMS.—Much interest has been aroused in and concentrated on the many different aspects of the housing problem which confront the Government at the present time. The suggestions which have been brought forward for the satisfactory solution of the difficulties involved have been many and various—in fact, they have been notably more numerous than sanely suggestive. The current number of "A Thousand and One Uses for Gas" (published by the British Commercial Gas Association) should be of absorbing interest to architects, builders, and housing authorities generally. It deals in some detail with the best and most economical domestic fittings which should be installed in the new homes when building, from the point of view of the tenants. Copies may be obtained, post free from the publishers at 47, Victoria Street, Westminster, S.W.1.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The full report of the discussion held by the Institution of Automobile Engineers at Olympia on November 27th on the judges' report on the motor cycle trials has now been submitted to the Auto-Cycle Union. One of the chief causes of complaint by the manufacturers seems to have been that no allowance was made by the judges for wear of machines previous to the trials, while a strong feeling was expressed that the somewhat severe criticisms of the judges ought to have been submitted to the manufacturers alone and not to the public generally. Opinions were also expressed that the judges in their report advocated too close adherence to motor car design, such, for instance, as by the recommendation of water-cooled engines and complete mudguarding. Many manufacturers expressed their opinion that the audiometer was not a satisfactory means of allowing judgment to be formed as to which were the silent machines. Valuable suggestions were made to the effect that credit should be given to the designer for refinements in design, such as comfort, engine flexibility, etc., and that next year's rules should legislate for a class of really light-weight machines, and that if possible the rules should be drawn up so as to obviate the necessity for any expression of personal opinion. The sixth meeting will take place at the Chamber of Commerce, New Street, Birmingham, on Thursday, 29th January, 1920, at 7-30 p.m., when Dr. A. H. Gibson will read a paper entitled "Air Cooling of Engines." Cards of invitation for either of these meetings may be obtained on application to the Secretary, Institution of Automobile Engineers, 28, Victoria Street, London, S.W.1.

Publications.

"Profit Sharing and Labour Co-partnership." This pamphlet (3d. net) is published by the Labour Co-partnership Association, 6, Bloomsbury Square, London, W.C.1, and contains speeches by the Rt. Hon. Lord Robert Cecil, M.P., and the Rt. Hon. J. R. Clynes, M.P. These speeches are not only an introduction to the modern aspects of profit sharing and co-partnership, but form an excellent illustration of the changed attitude of public men towards the industrial problems. The human side of industry is recognised as of fundamental importance for the progress of industry and for the welfare of the State. The pamphlet is well got up and well printed. Cross headings and special type are used to bring out the salient points and so enable the enquirer to find quickly whatever is to him the particular point of interest. A short list of other publications of the Association is given at the end.

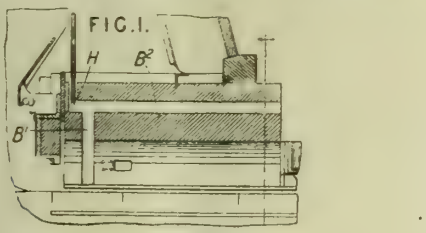
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

FURNACES.

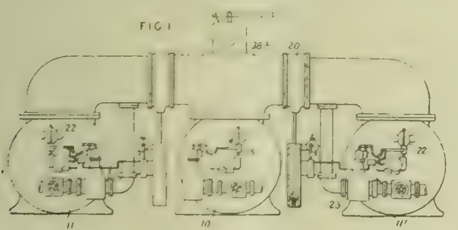
123,820.—W. L. SHAND, St. Claire, White Rose Lane, Woking, Surrey.—(W. Stone, 1, Selborne Road, Kew, Melbourne, Australia.) —March 6th, 1918.—The arch above the grate of a water-tube boiler or other furnace is made with one or more ducts B1, B2, and

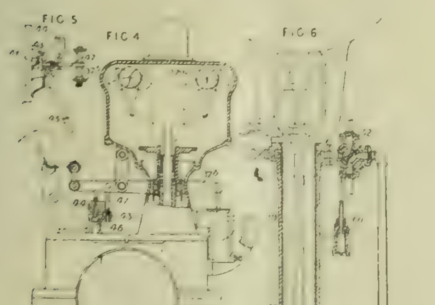


preferably is fitted with means for supplying jets 11 of steam compressed air, or other fluid, so that the smoke, etc., rising from the fresh fuel is drawn through the ducts and discharged into the combustion chamber.

GOVERNING TURBINES, ETC.

124,202.—BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., 2, Norfolk Street, Strand, Westminster (Assignees of F. Hodgkinson, 150, Lloyd Street, Edgewood, Pennsylvania, U.S.A.)—July 8th, 1918.—Relates to governing means for compound engines or turbines, and comprises means responsive to variations in the speed of the high-pressure section for controlling the operation of the low-pressure section and means responsive to variations in the speed of the low-pressure section for shifting the function of governing the low-pressure section from the first to the second of said means. For example, in a turbo-generator installation, Fig. 1, comprising a high-pressure turbine section 10 and two low-pressure turbine sections 11, 11¹ connected in parallel, in the event of an accident unloading, say, the

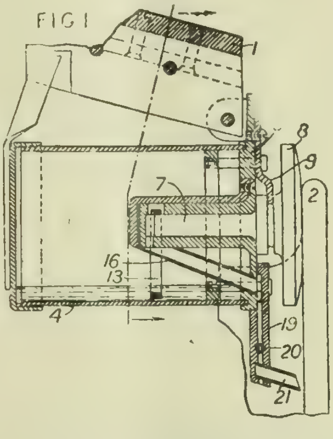




section 11¹, the sections 10, 11 continue in operation under load under the control of the governor 15 of the high-pressure section, while the section 11¹ is automatically isolated by a governor 22, which is adapted first to cut off the fluid supply coming from the section 10 by closing a gate valve 20 when the speed of the section 11¹ becomes excessive, and then to admit sufficient live steam through a valve 23 to keep the section 11¹ running at normal speed. Excess fluid from the section escapes through a relief valve 28*a*. A modification is described wherein a high-pressure turbine is connected in series with a duplex low-pressure turbine by a conduit having a gate valve such as 20. An application of the invention to the turbine described in Specification 17,643/14 is described, and in this modification, the gate valve may be closed by the governor of the initial section. The control of the gate valve may be effected by a governor 37*a*, Fig. 4, controlling a pressure-actuated device 39, Fig. 6, and a trip mechanism 43, Figs. 4 and 5. Mounted on the governor lever 37*b* is a finger 47 adapted to release from a latch 46 a trip lever 45 and so allow a valve 44 to open and permit the space below a differential piston 60 to be exhausted. The piston 60 thereupon shifts a valve 52, admitting pressure fluid below a piston 49, which thereupon shuts the gate valve mounted on its rod 50. For subsequently opening the valve admitting high-pressure steam to the low-pressure section, the governor 37*a* is connected thereto through a relay.

LUBRICATORS.

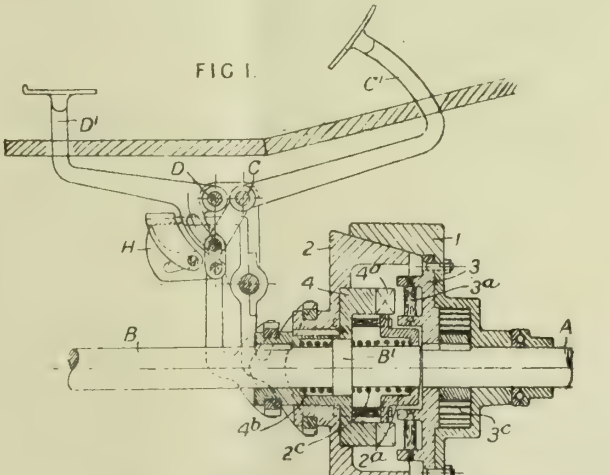
124,170.—A. ROTH, Chernex-sur-Montreux, Switzerland.—Dec. 23rd, 1918.—A device for supplying lubricant to the flanges of railway-vehicle wheels is operated by the movement of the wheels. A roller 8, rotated by contact with the wheel flange 2, is formed on a spindle 7, on which hangs a loose ring 13. Oil raised by



the ring from a reservoir 4 passes through passages 16, 19 to a spout 21 which delivers it to the flange, over which it is distributed by movement of the roller 8. The reservoir 4 is mounted adjustably in an inclined slide 1. The roller 8 and spindle 7 are held in place by a fork 9 secured to a cover 5. The delivery is controlled by a valve 20.

CLUTCHES.

124,226.—J. E. HOLT, 293, Sheffield Road, Tinsley, and W. HARPHAM, Victoria House, Wincobank, both in Sheffield.—July 30th, 1917.—Relates to a combined friction and positive clutch for motor-vehicles, aeroplanes, motor-boats, etc., of the type wherein the friction clutch must be in engagement before the positive clutch, and the friction clutch when disengaged disconnects the positive clutch. The friction member 1, to which is attached the positive member 3, may be secured to the driving-shaft A by a coiled



spring 3*c*, and the friction member 2 is movable on the positive member 4, which is slidable on the driven shaft B. The member 2 is pressed into engagement by an internal spring 2*c* bearing on the shaft collar B1 and a cap 2*a* attached to the member 2, and the member 4 is pressed out of engagement by an internal spring 4*b*. Pedals C1, D1, acting through rocking shafts C, D and link-work connected by pins and slots, are provided to withdraw the

member 4, which is slidable on the driven shaft B. The member rack locks the pedal levers in the depressed position. The member 3 is provided with radial rollers 3*a* adapted to engage the teeth 4*a* of the member 4.

BEARINGS.

124,267.—R. B. NORTH, 14, Soho Square, Soho, Westminster, and A. M. ALLEN, 142, Queen's Avenue, Watford, Hertfordshire.—March 19th, 1918.—A ball-bearing casing for a magneto-electric machine is made in two parts *a*, *a*1 each formed with a spigot *a*2, *a*3 fitting into an opening in the wall *c* of the machine, which may be formed as a hollow boss *b*2 containing a chamber, to

FIG 1

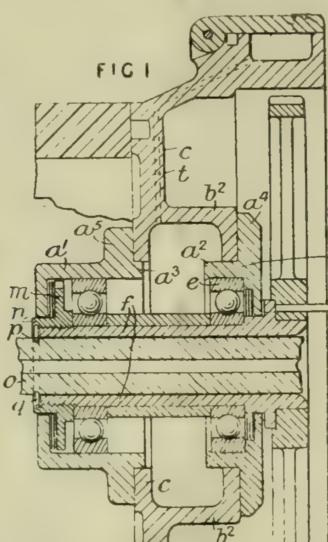


FIG 2

which lubricant is supplied through a passage *t* in the wall. Flanges *a*4, *a*5 on the casing parts are fixed to the wall *c* by screws. To hold a distributor spindle *o* against end movement in a sleeve *f*, and annular corrugated spring *q*, in one or two parts is sprung into a groove *n* in a nut *m* and into a groove or series of depressions *p* in the spindle *o*. The ends of the spring may be bent into a slot in the end of the sleeve *f*. The ball race *e* is held in position by burring over the edge of the spigot *a*2.

ROTARY ENGINES.

124,284.—P. G. TACCHI, Bay Tree House, New Wanstead, Essex.—March 21st, 1918.—Fuel is compressed between the vanes of the two rotors of an internal-combustion rotary engine and is ignited at or near the point of maximum compression, and expansion takes place as the teeth recede. In both forms of engine shown, the fuel is compressed between the teeth of the two rotors into the space E2, in which it is ignited either

FIG I

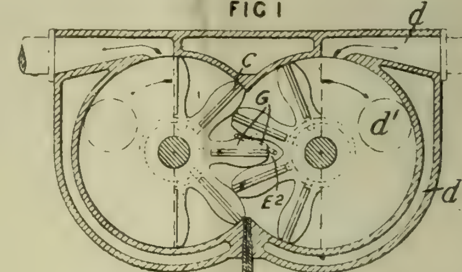
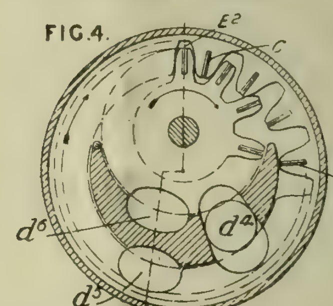


FIG.4



electrically or by a flash-passage G from the last-fired charge. In a modification, liquid fuel may be injected into the compression space and ignited by the heat of compression. Burnt gases escape through the ports *d*, *d*4, and scavenging-air is forced through the rotor chambers through ports *d*1, *d*5, *d*6. A water jacket *d*3 is arranged round the casing. The vanes are divided and fitted with overlapping packing-plates C which are pressed radially and axially by springs.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

THE NEED FOR INDUSTRIAL PROPAGANDA.

WHATEVER side we may take in our view of the moulders' strike—or any strike or lockout—we cannot help but deplore the great loss to the country generally. Never in the wildest prophecies of those who, during the war, had ideas as to the period immediately succeeding the war, did we come across any suggestion of the general turbulent unrest that we have experienced during the past twelve months. War conditions, war regulations, war allowances, are responsible for our present position. The mistake was made in 1914 when, instead of conscripting the whole nation, the Government dallied with the matter, and adopted a wait-and-see policy that resulted in half-hearted measures.

That we have come out of the war as well as we did is a matter of congratulation, but during those years of stress and struggle the foundations were laid for our present industrial strife. One particular feature of war-work was that of propaganda in neutral countries. An immense amount of useful work was done, and the best brains of the country were co-opted with a view to the accurate and definite presentation of the case of Great Britain. Why cannot this work be carried on in our own country?

During these days of reconstruction, we want the fact driven home to each and every worker that for four-and-a-half years the countries engaged in war have been manufacturing money and not goods. The face value of that money has depreciated enormously, and the purchasing power of a £ is down somewhere near 8s. 3d. Increase in wages increase a vicious circle, and the only solution of our present plight is increased production. This can only be secured by hearty co-operation of Capital and Labour. It should be brought home to all engaged in industry that 100 per cent efficiency must be obtained. Take any trade you like, and analyse the present production, and then compare it with pre-war work. It will be found that even with shorter hours the operative is not producing as much per hour as formerly. Surely this is wrong.

We want an organised campaign—an educative campaign—in which all the facts are assembled to prove to the worker that he is helping himself by giving wholeheartedly of his best, and that merely raising his wages will not prove the panacea for all ills he believes.

A NEW THEORY OF PLATE SPRINGS.

By DAVID LANDAU AND PERCY H. PARR.

(*Continued from page 114.*)

Now using these values for the C's, the various deflection relations may readily be calculated, giving the values of the A's, after which the B's and C's for the spring are to be found in the same manner as in the earlier example. It must, of course, be noted that the C's of equation (12) for the spring are not the C's of the above table; in the table the C's are the constants of integration as found from equations (43) and (44), while the C's for the spring are those found from equation (12). The use of the same symbol for denoting the two different things will not be found to cause any trouble in practice. The results of the calculations show that the various con-

stants for the spring have the values given in the following table :

n	A_n	B_n	C_n	W_n
1	.00212	.00212	.631	1.000
2	.00000	.00207	.795	1.585
3	.00178	.00241	.869	1.993
4	.00245	.00288	.904	2.294
5	.00362	.00345	.930	2.537
6	.00245	.00410	.895	2.728
7	.00328	.00455	.871	3.049
8	.00426	.00481	.617	3.500
9	.00580	.00339		5.673
11	.00546			
12	.00682			
13	.00880			
15	.00846			
16	.01025			
17	.01271			
19	.01235			
20	.01465			
21	.01772			
23	.01360			
24	.01584			
25	.01871			
27	.01448			
28	.01662			
29	.01930			
31	.00575			
32	.00651			
33	.00741			

The values of A_{10}, A_{14}, etc., have not been given in the table, as they are respectively equal to A_8, A_{12}, etc., according to the theorem.

If we allow a stress of 100,000 lbs. per sq. in. in the bottom or short leaf, then the safe load on it will be $(100000 \times .01197)/5.6 = 214$ lbs. and a corresponding load on the short end of the spring, or W_9, will be $214 \times 5.673 = 1210$ lbs. The stiffness $= 1/B_9 = 1/.00339 = 295$ lbs. load per inch deflection. Allowing for the difference in the lengths of the two ends of the actual spring, this stiffness of the short end corresponds to a stiffness of 425 lbs. per inch for the entire spring.* All of the above figures have been calculated on the assumption that $E = 28 \times 10^6$, but a number of tests made some years ago showed that on an average E is slightly under 29×10^6, and adjusting the stiffness to this latter figure for E, it will be found that the calculated stiffness is 440 lbs per inch. The average tests of several hundreds of these springs showed that the stiffness was 447 lbs. per inch, so that the agreement is very good indeed, the difference being well under 2 per cent, while commercial springs of the same batch will at times vary 5 per cent as a maximum. The agreement is, therefore, within the limits of manufacturing accuracy.

In order to complete the study of this spring, we must calculate the stresses in the various plates. The lower plates present no difficulty, and for the top "compound plate" the load carried by each of the two plates is directly proportional to its moment of inertia, so that the thick plate No. 10 carries $1210 \times .004013/.006579 = 740$ lbs., and the thinner plate No. 9 carries the remainder, or 470 lbs. On performing the necessary calculations it will be found that the maximum stresses in the various plates at the centre point of encastrèment, are as follows :

Plate No.	Stress.
1	100000
2	95500
3	96600
4	97500
5	100000
6	100000
7	119000
8	106000
9	165000
10	192000

from which it will be seen that the greatest stress in this spring occurs in the top or master leaf. If the maximum stress in the spring is to be limited to 100,000 lbs. per sq. in., then the safe load on the short end will evidently be $1210 \times 100{,}000/192000 = 630$ lbs., which will give the allowed stress in the master leaf, the stresses in the lower leaves being then all smaller; the total safe load on the spring on the same basis being 1,133 lbs.

The taper which is now under consideration is so important that it appears to be advisable to work out this spring on the assumption that the leaves have square points (No. 1) in order to show the great difference made by the tapering. If this spring is worked out by the equations for the square point, it will be found that the reactions, etc., are as follows :

n	W_n	Stress.
1	1.00	100000
2	1.49	83700
3	1.76	74100
4	1.93	69800
5	2.03	64100
6	2.11	64500
7	2.26	71900
8	2.48	79200
9	3.74	98800
10		114000

The total safe load on the short end of the spring with a stress of 100,000 in the short leaf is 800 lbs., and with the same stress in the master leaf it is 700 lbs., while the stiffness of the short end is 321 lbs. per inch; this is a total spring stiffness of 479 lbs. per inch, and a total safe load of 1,225 lbs.

A comparison of these figures with the corresponding ones for the tapered ends shows that the differences are very great; the final reaction in the case of the tapered spring has been increased by over 50 per cent, and the stress in the master leaf by nearly 70 per cent. With the trap', and other types of points which are tapered in the width only, the difference due to tapering has been shown to be in the neighbourhood of only 1 per cent, so that they are of no practical value, but the above example shows that tapering in the thickness may produce relatively enormous effects, and that almost every kind of stress distribution can be obtained by a suitable combination of tapering in the thickness and grading. It is not suggested that the particular example chosen for illustration is a good one; in fact, it will be seen that the safe load for the tapered spring in this particular case is slightly less than for the non-tapered one, though the tapered spring is the more flexible. This spring is an old design, produced sometime before the full effects of tapering were properly appreciated, with the consequence that the stresses in the upper part of the springs were some-

* For a complete study of the deflection of an excentrated spring the reader is referred to an article entitled "The Partial and Total Deflections of Leaf Springs *En Masse*," in the *Horseless Age*, January 20th, 1915; January 27, February 10th, February 17th, February 24th, March 3rd, March 17, March 24, 1915, by David Landau and Asher Golden.

what excessive, and in use the master leaves were generally the first to break. By properly adjusting the tapers, the stresses can be made very nearly equal throughout the spring, with a corresponding benefit, for in this case all of the metal is used to the greatest possible advantage. There are other modifying circumstances, which will be dealt with in our third paper, which tend to increase the stresses in the lower leaves and decrease them in the upper leaves, so that, ultimately, the stress distribution is better than would appear from the above figures for the tapered leaves and actually the tapered leaf spring is better than the untapered one, though the above figures tend to show the reverse.

We now pass on to a study of the leaves which are tapered in the plane of the width as well as in the plane of thickness.

No. 7 or Trapezoidal-tapered Leaf Point.

This type of point is shown on a larger scale in Fig. 25, which figure also shows the symbols which will be used in the analysis. The effects of the taper in the width are usually of secondary importance as compared with the effects of the taper in the thickness, but, nevertheless, there are cases where they are considerable.

In order to find the deflections of leaves with the No. 7 point, we must note that there are several possible cases: for the present the two cases which have to be noticed are those for which $c > a$ and for which $c < a$. The first case, which is the most usual one, is shown in Fig. 25, and for this it will be noticed that from $x=0$ to $x=l-c$ the cross-section

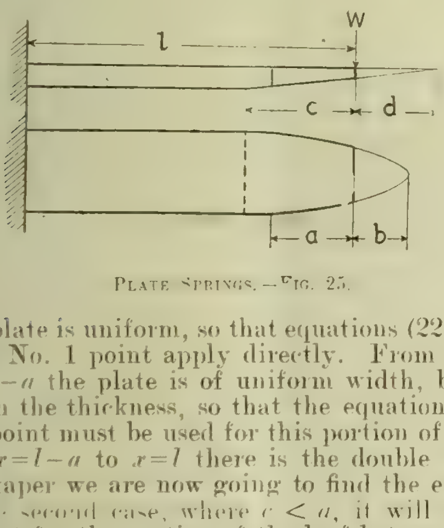


Plate Springs.—Fig. 25.

of the plate is uniform, so that equations (22) to (24a) for the No. 1 point apply directly. From $x = l - c$ to $x=l-a$ the plate is of uniform width, but has a taper in the thickness, so that the equations for the No. 6 point must be used for this portion of the leaf. From $x=l-a$ to $x=l$ there is the double taper for which taper we are now going to find the equations. For the second case, where $c < a$, it will easily be seen that for the portion of the leaf between $x=l-a$ and $x = l - c$ the thickness of the leaf is constant, but the width is tapered, so that the equations for the No. 2 point are directly applicable to this portion of the leaf.

For the Double Taper of Fig. 25, from $x = l - a$ to $x = l$.

For this portion of the leaf, it is readily seen that:

$$I = I_0\left(\frac{l+b-x}{a+b}\right)\left(\frac{l+d-x}{c+d}\right)$$

so that:

$$\frac{EI_0}{W}\frac{d^2y}{dx^2} = \left(\frac{a+b}{l+b-x}\right)\left(\frac{c+d}{l+d-x}\right)^3(l-x)\ \dots\ (45)$$

In order to integrate this expression, it seems best first to put into the equivalent form:

$$\frac{EI_0}{W}\frac{d^2y}{dx^2} = (a+b)(c+d)^3\left\{\frac{1}{l+b-x}\right\}$$

$$\left\{\frac{-d}{(l+d-x)^3} + \frac{1}{(l+d-x)^2}\right\}$$

Then if we put:

$$z = \frac{l+b-x}{l+d-x}$$

we find that, so long as b is not equal to d:

$$x = l + d - \frac{d-b}{(1-z)}$$

and

$$dx = -\frac{d-b}{(1-z)^2}\,dz$$

also:

$$l+b-x = \frac{(d-b)z}{1-z} \text{ and } l+d-x = \frac{d-b}{1-z}$$

whence, after integrating:

$$\frac{EI_0}{W}\frac{dy}{dx} = \frac{(a+b)(c+d)^3}{(d-b)^3}\left\{\frac{dz^2}{2} - (d+b)z + b\log z\right\}$$
$$+ C_1 \ \dots\dots\dots\dots\dots\dots\dots\ (46)$$

For the cases where the points of the leaves are tapered in both the width and in the thickness, the mathematical expressions for the constants (C's) of integration become so complex that it does not appear to be useful to give them; it seems to be better to evaluate them numerically when required. It is evident from considerations of continuity, that for the leaf point of Fig. 25, the value of dy/dx given by equation (46) for $x = l - a$, where the double taper commences, must be equal to the value of dy/dx given by equation (41) for the shorter portion of the leaf, for the same value of x. The procedure for finding C_1 is therefore to calculate the value of dy/dx for $x=l-a$ by means of equation (41) and then to insert this value in the left-hand side of equation (46), which, combined with $x=l-a$ on the right-hand side, allows of the value of C_1 being calculated.

A second application of the substitution used for integrating equation (45) allows of integrating the integral equation (46), and, after absorbing the constant part of x into the constant of integration C_2, we obtain:

$$\frac{EI_0}{W}y = \frac{(a+b)(c+d)^3}{(d-b)^2}\left\{d\left(z - \frac{1}{1-z}\right) + \frac{2b}{1-z}\right.$$
$$\left.(z\log z - 1)\right\}\left\{-\frac{d}{1}\ \ b\right\} + C_1 + C_2\ \dots\dots\ (47)$$

C_2 must be found in the same manner as described for C_1, by equating the values of y from equations (42) and (47) for $x = l - a$. For the other cases, if $c = a$, it will readily be seen that the equations for point No. 1 must be used for comparison when determining the values of the C's, and if $c < a$, then the equations for point No. 2 must be used, instead of those for the No. 6 point referred to in the preceding analysis.

(*To be continued.*)

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

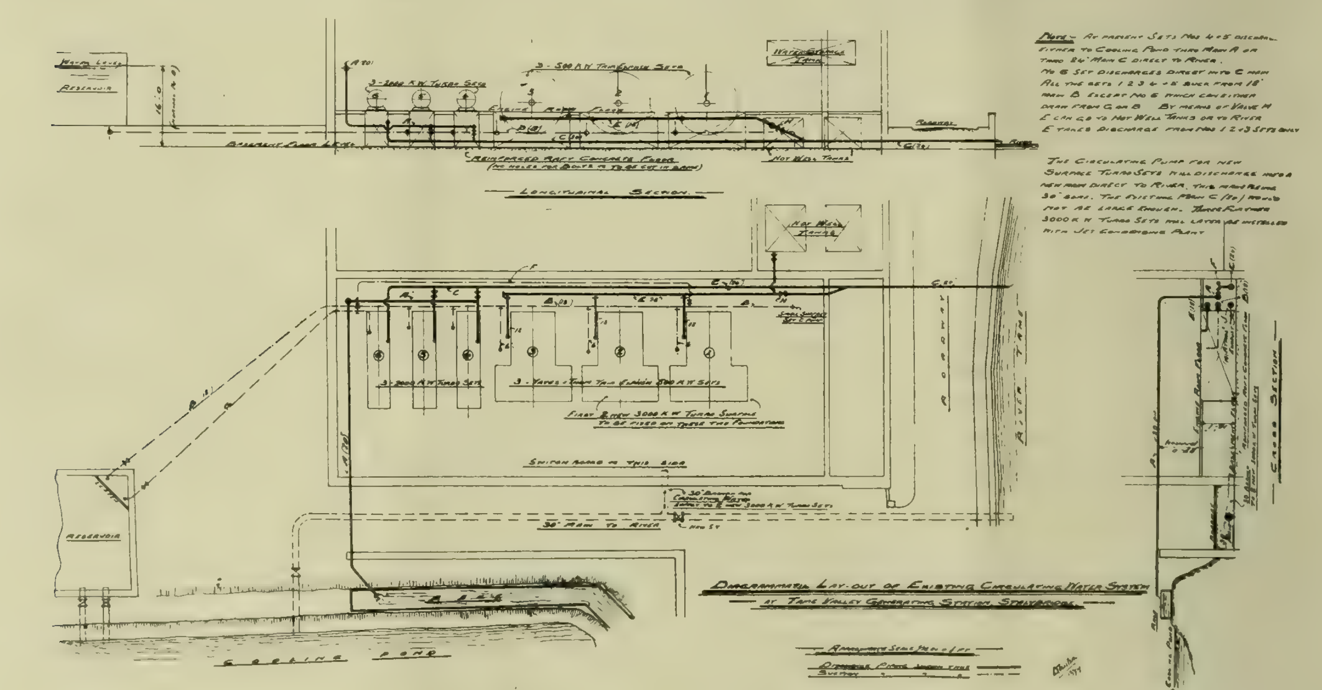
(*Continued from page 48.*)

I am now going to give a brief description of the general layout of the recently re-equipped Power Station at Tame Valley, Stalybridge. This very unique installation was carried out all through under the directions and supervision of the Engineer-in-Chief to the Stalybridge, Hyde, Mossley, and Dukinfield Tramways, Mr. Robert Blackmore, A.M.I.E.E., whilst the turbo-sets, condensers, air and circulating pumps, &c., were built and erected by Messrs. the British Westinghouse Electric and Manufacturing Company, Trafford Park.

I am not dealing with the electrical portion of the installation, but simply the layout of the units and piping water system was wanting, so this meant a day or two on the site by the draughtsman.

Full particulars were then required, giving sizes of existing suction discharge, and any other mains, also the normal yearly head available at the cooling pond, and, in short, any other particulars the Chief Engineer could let the draughtsman have.

The diagrammatic layout of this piping, &c., as made from the draughtsman's particulars, is shown at Fig. 87, and it will be seen that the station contained six power units, Nos. 1, 2, and 3 being three 500 k.w. triple-expansion steam alternators, by Messrs. Yates and Thom, and Nos. 4, 5, and 6, turbo-alternators each 2,000 k.w., by Messrs. Willans and Robinson. The proposals were that five new turbo-alternators, each of 3,000 k.w. output, should be installed in the station, the first two sets to rest, if possible, on the existing concrete foundations to the Nos. 1 and 2 Yates and Thom sets, though a certain amount of cutting away



Engineering Lay-out.—Fig. 87.

generally, and I hope, after a short description, and a few remarks on the execution of the drawings, &c., the same may be of some use to the draughtsman engaged in this branch; if not, may at any rate interest him.

The first thing necessary before any working drawings were made, or even sizes of pumps, &c., were fixed up, was some particulars of the existing power house, circulating water pipes, foundation drawings of existing sets, &c., to enable the contractors to see exactly what new mains to get laid down, and whether the present head of water at the cooling pond was sufficient to meet the demands of the first two new sets, which were surface condensing; also whether it was possible to utilise the present massive concrete foundations under the existing 500 k.w. Yates and Thom triple-expansion steam alternators for the foundations of the two first 3,000 k.w. turbo-sets.

A general plan of the station was available, also foundation plans of the Yates and Thom sets, but the position of the water mains and general layout of the

of the same would be necessary, also some 3 ft. adding to the height to accommodate the condensers, exhaust, sluice valves, &c. The other three new sets, which would be provided with jet condensers, on account of the insufficiency of head necessary for the circulating water supply, and also the want of space required by surface condensers, renewing tubes, &c., were installed as follows; No. 3 (the first of the new jet sets) between the new No. 2 surface set and the existing No. 3 Yates and Thom alternator, there only just being room without undue cramping to get this plant in, as will be seen on a drawing of the layout later. The second jet set was placed on the river side of the station, 17 ft. 6 in. centre to centre from No. 1 turbo set, and the third jet set at the other end of the station, as will be shown on another plan. The general layout of the new sets will be seen and described further later.

Thus it will be realised that this installation called for no small amount of foresight on the part of the engineers, whose chief object in view whilst the work

on the new units was being carried out was to leave the existing sets running where possible up to the last hour of their being removed, and this they achieved admirably.

It was first thought that probably the existing 24 in. main C would serve to take the circulating water discharge from the new surface sets to the river, and alternatively through A main to cooling pond, but this was found to be a "tight fit," and it was decided to put in a new 30 in. main in its place direct to river.

As will be seen from the layout, the circulating water supply to these first new sets was to be taken off the existing 30 in. underground main from cooling pond to river, a new branch pipe, tee, sluice valve, &c., being required for this.

The river gets very low in the summer, often resembling a very shallow stream or ditch; without it however, a great number of the large mills in the neighbourhood would have to close down. The bottom is below the basement floor level of the power house, hence the danger of tapping this for bolts, &c.

The whole floor was one vast reinforced raft of concrete, as indeed it was most essential for it to be so.

(To be continued.)

JIGS, TOOLS, AND SPECIAL MACHINES WITH THEIR RELATION TO THE PRODUCTION OF STANDARDISED PARTS.

By Herbert C. Armitage, of Birmingham, Associate Member.

(Concluded from page 135.)

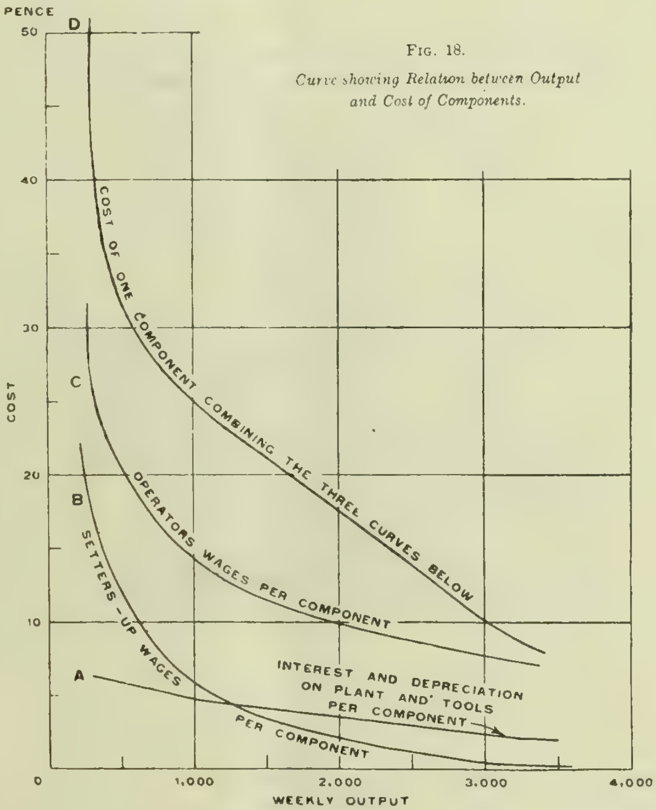
Comparative Results between the Three Schemes.

By totalling up the machine-tool values, expenditure in jigs, and the labour costs, the following results are obtained, in spite of the fact that a connecting-rod does not lend itself exceptionally well to manufacture by special machine tools, Table 6:—

TABLE 6.

	Small Production.	Large Production.	Maximum Production.
Weekly output	300	1,000	3,000
A. Total No. of machine-tools involved	16	33	47
B. Operator's wages, say, 10d. per hour per one rod	25·9d.	14·5d.	7·7d.
C. Setters up wages, say, 1s. 8d. per hour per one rod	18·0d.	6·0d.	0·25d.
D. Total approximate value of jigs required	£225	£855	£1,260
E. Total approximate value machine tools	£2,400	£5,850	£9,200
F. Weekly cost of plant upkeep, say, 10 per cent depreciation, 5 per cent interest on capital	£7·9	£20·1	£29·4
G. Plant cost per rod	6·3d.	4·8d.	2·3d.
H. Total cost of rod. (Sum of B.C.G.).......	50·2d.	25·3d.	10·25d.

The figures are somewhat startling, and show that an approximate trebling of production reduces the manufacturing cost in each case by about one-half. Other charges (which have not been shown), such as management, power, establishment, etc., will be practically the same in each case. By referring to the operation tables, it will be seen that in each scheme the same finishing methods are to be employed, namely, the turret lathe. Where, in the small production layout, two lathes are required, there will be twenty necessary to cope with the largest output. The great economy shown, therefore, will be tremendously accentuated if special finishing machines could be employed. Under each scheme a properly balanced plant has been assumed. If there is an output of less than the maximum per week, the working costs will be increased, as part of the machines would be idle.



Jigs, Tools, etc.—Fig. 18.

Figures for the wearing tools (that is, milling cutters, drills, broaches, etc.), costs have not been added, as they will be almost proportionate to the output. There is sure to be a slight reduction per connecting-rod in the large productions, for by manufacturing or buying in large quantities, they should be obtained at much lower prices. The figures have been set out in the form of a curve in Fig. 18.

Lines of Future Development.

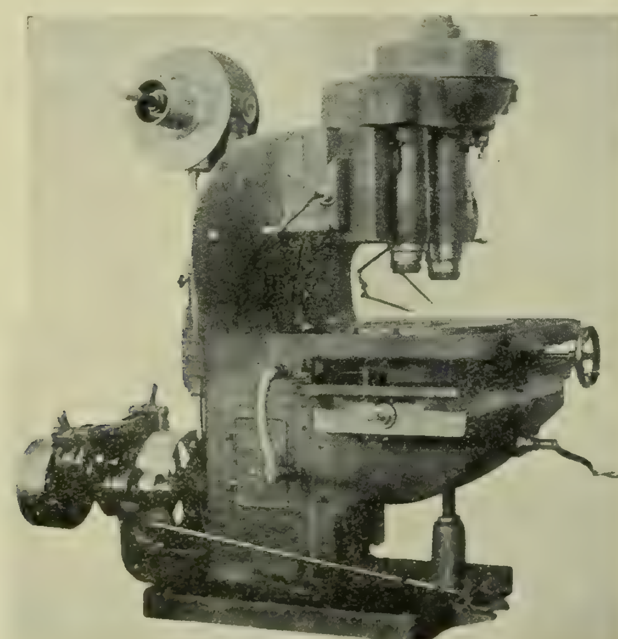
In conclusion, a few notes must be added regarding the future developments of tools for interchangeable and repetition production. The war has only thoroughly awakened us to the huge possibilities of accurately working to standardised dimensions and given limits for component parts. It is doubtful (though

possible) that before the war, there was an English motor-car built with absolutely interchangeable parts. It is a certainty that motor-cars not built on interchangeable lines will cost such a price after the war that the maker will not find a market for them. This will apply to everything of a similar nature, and since standard ships are now an accomplished fact, standardised houses, motor-cars, auto-carriers, typewriters, and domestic machinery may be expected in this country. This being granted, the importance of special and precision tools will be enormously increased. Reliable and standard limit systems, both of first degree for manufacturing, and of a second degree for tools, to suit modern methods and for all classes of work, must be framed, from the experience gained in the use of the several existing systems, all of which are far from perfect. Further, skilled labour will be very scarce, and since our industrial success depends upon an abundance of special tools, improved and quicker means must be devised for making them. During the war we have learnt how to make screw-gauges, almost on repetition lines. Surely the same concentration might be exerted upon precise methods of locating and boring holes for jigs or other precision work. Imagine, for instance, an optical measuring or spacing device, and a method of boring holes to within half a thousandth limit in the centre distance, without revolving the work. This is again the plea for a means of accurate machining with a revolving tool, for having once obtained accurate precision cutting by a revolving tool, a jig-bush hole boring machine with micrometer and vernier settings to bore in several planes at once, and capable of being set up in a few minutes, would soon be a feature of every tool-room. Again, there is considerable scope for investigation in the methods of hardening high-speed and tool steels without deformation of the metal. It is safe to state that if steel-makers do not produce non-shrinking and non-warping steels, progress can only be obtained by greater perfection of the grinding machine and its wheels, and extending considerably the use of formed wheels.

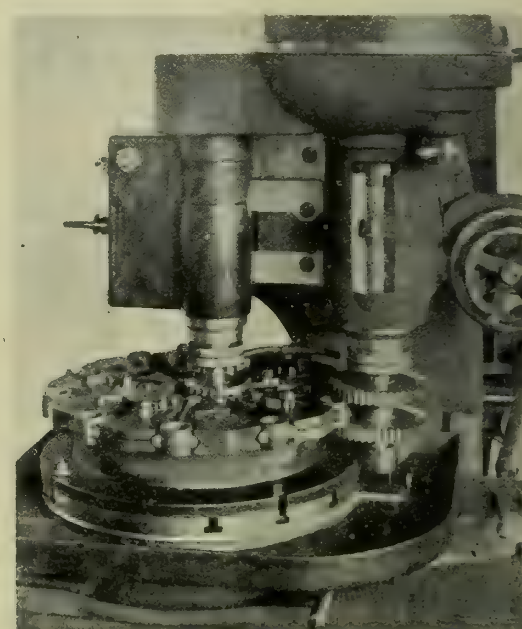
One of the greatest manufacturing troubles now experienced on aero-engine parts is in the nickel-steel case-hardened parts. Several heat treatments are usually necessary, and even then, after hardening, the component usually twists and distorts out of shape or increases in size. This will undoubtedly develop grinding processes rapidly, and considerable ingenuity has to be given to the order in which operations are to be performed between carbonising and quenching the piece.

The whole tendency of tool design is in the direction of more "fool-proof" jigs, therefore making more complex and larger jigs necessary. If this can be done with a degree of standardised tool parts, and with easier methods of producing precision work, to avoid trial and error settings when building the tools, there need be no fear for the development and increase of engineering production for the next few years to replace war wastage.

(*Concluded.*)



General View.



Milling Ten ½-inch Connecting-rods.

Double Spindle Continuous Miller (Becker).

The British Electrical Federation Limited. We are informed that the British Electrical Federation and most of its member companies have returned from the Manchester Hotel, Aldersgate Street, to Electrical Federation Offices, 88, Kingsway, over the Holborn Station of the Piccadilly Tube Railway. As the Government has retained part of the building, the engineering and stores departments of the Federation are for the present located in adjacent premises at 11 13, Southampton Row, while the Electrical and Industrial Investment Company and other finance companies are at 4, Broad Street Place, E.C.

CAR DESIGN AND CAR USAGE.

By Edgar N. Duffield.

(*Continued from page 130.*)

It is so very easy to eliminate possibilities of trouble arising from "splash" lubrication that we shall probably, in the course of a very few years, see great accessions to the number of manufacturers employing it. Gradually, designers will adhere less and less to the practice of doing things in a certain way simply because that way was practised by designers in the earliest days of the internal-combustion motor. We can quite understand why steam engineers, when first flirting with the petrol motor, took excessive precautions with the lubrication of anything working at such—to them—high speeds. When a man who had never gone above 250 revolutions per minute discovered that in order to get useful power he must risk 1,000 and even 1,500 revolutions per minute, it was natural for him to wonder whether his bearings would stand such speed. He would inevitably at once think of forced feed lubrication, and thus the positively-driven oil pump and the drilled crankshaft came in, *not* because of necessity, but simply because the early designers wanted to be on the safe side—a very proper mental attitude at the time, but one which need no longer govern or dictate design in this particular matter.

When three first-rate firms like De Dion-Bouton, Delaunay-Belleville and Maudslay all proved the efficiency and economy of pumping oil through their crankshafts, it was natural that other firms' designers should follow suit, and so this bit of practice was hall-marked, as it were, as being the only thing to be contemplated by really first-grade constructors.

To come now to a small but all-important point, the lives endangered and the money lost by insecure nuts are past all computation. First, then, the author would like to see every nut a lock-nut of one or other of the patterns which simply cannot be vibrated out of security. There are several types of nut, which need not be named, which have satisfactorily withstood very test, in the dust of cement-manufacture and the constant oil bath of lubricant-refining, any of which would serve; trial suggests that they are equally efficient. Such nuts are not used, apparently, even by the best British constructors of omnibuses, but they should be, and will be when car users begin to get to know of them and demand them. They cost more than simple, single nuts obviously, but then good material or components of any nature cost more than inferior things, and the total cost of the nuts used on a chassis is not a bulky item of the bill, anyhow.

Speaking of nuts suggests adjustments. These must eventually be reduced almost out of necessity, so that the discriminating buyer will not, and the other kind cannot, be for ever busy with spanner or wrench. If a thing can be made to run without constant adjustment, we must have it so made.

Another elimination is that of the maximum possible number of points which require lubrication. These can be reduced in number with surprising ease. But when we come to cut down the number of contact surfaces at which we must lubricate, we must make sure that oil or grease fed into apertures near them will really get to the places it is intended to serve. It is idle to cut a spiral grease channel or oil-way in, for example, a spring shackle bolt if that grease-channel or oil-way is to be left unprotected, so that it will get choked up with worn metal, grit or dust. There is a very simply effective means of preventing this choking, patented by the Streatham Engineering Co. Ltd. Another very useful device emanating from the same source is a grease cup or Stauffer pattern lubricator, so constructed that its whole contents are forced into the bearing it is fitted to grease. With the ordinary grease cup, everybody knows how a good half of the lubricant is squeezed out of the lubricator, to remain on its surface and collect dust and grit. The Streatham firm's Stauffer, is so built that all the grease put into the cup is forced into the bearing, and none squeezes or sweats outside. It always did squeeze out and always will while we continue to use the old type of greaser.

On this point, the author cannot too strongly condemn the principle of relying upon lubricants to "find their way" into bearings at some distance from the point of actual application. A quite new car embodies two, if not more, examples of the application of this principle, the sponsors for the production blandly saying in their own sales literature that oil "will find its way" to certain bearings sustaining quite heavy duty. This "way-finding" may be a pious hope, devoutly cherished, but it is nothing more in nine cases out of ten, and it should not be tolerated for another week in the motor engineering of the twentieth century. Lubricants will find their way between piston and cylinder because those surfaces are bathed in a mist of oil molecules, as also are our main bearings—and in most cases those of connecting rods and camshafts—at least as long as the crank-case is duly replenished; but "finding its way" is a reminder of "muddling through." The author does not like these vaguely comforting phrases in anything so serious as engineering, meagre as is his real respect for a lot of the sentiment attaching to engineering practice.

Still on lubrication, design of crank-case oil-fillers should be improved in such wise that everybody can use them without incurring avoidable mess or bother. The bigger, higher and more securely fastened the orifice through which engine oil must be poured, the more of it will be poured. Replenishing the sump of an engine can never be a pleasant job, but it need not be purgatorial, as so often it has been, and is to anybody with any regard for his or her clothing.

The device used to show the level of oil in the sump, also, must be in plain view the moment the engine is uncovered on the side of the crank-case on which it is fitted. A child of ten should be able to see at a glance whether the oil level is too high, just about right, or dangerously low. Gallon, litre or other quantitative markings are silly. If there is any lettering it should be on the lines of "Over-full," "Right" and "Too Low," and if a dash-board tell-tale is provided it should be a "dry" one, merely passing on the motion of the level float or other crank case gauge. If it is so arranged, we shall not have oil sweating on to the instrument board. To allow oil to be pumped to the instrument board, merely to show that the sump contains oil, and the pump is working, is to say the least of it crude.

What applies to the replenishment of the crank-case obviously applies also to that of the gear-box

and rear axle casing. Of 300 cars in current use which the author knows, only about six have what he considers proper provision for the lubrication of the gear-box and rear axle without the use of a garage pit or mat on which to grovel beneath the car, and—humorously enough—the half-dozen which *are* decently provided in this respect are by no means the most costly cars of the day.

Here the author would like to interpolate a plea for oil everywhere. The use of grease is really an admission of ignorance as to how to apply oil efficiently to a given bearing. Grease will go from our cars just as it has gone from our gear-boxes. There are to-day plenty of oil containers which are leak-proof and jar-proof, and the author considers that grease has no place upon a modern car even in the case of steering details.

Universal joints, in either the clutch or propeller shafts, should not need more than monthly (that is, about 1,000 mile) lubrication and neither they nor steering connections should any longer be encased in leather bags, which are a nuisance from first to last, and thoroughly out of place on a modern machine.

The designer must, the author insists, bear in mind the fact that the average user of cars—and it is he or she for whom the designer is working, be it remembered—will be twice as likely to supply lubricant to a car requiring it only at twelve points as to one requiring it at twice that number. The exceptional user, who revels in lubrication, adjustment and general tinkering, exists, admittedly, but not in such percentage as to keep even a very small single works running to-day. Whether the average buyer says so or not, whether he knows it or not, if we ask him he wants to do as much motoring and as little tinkering as he possibly can with his car. This sounds axiomatic, but there are still many designers who will cheerfully pass a set of drawings containing thirty lubrication points, at which oil and grease must be applied periodically. Why then, hesitate to tell them that a car lubricated only at six points would be lubricated five times as regularly and thoroughly?

(To be continued.)

IRON CEMENTS.

SOME VALUABLE ACCESSORIES.

Written and Illustrated by James Scott.

"Indispensable in iron and steel foundries, and engineering workshops, for treating defects in castings, stopping up sand-holes, blow-holes, repairing leaky boilers, steam-pipes, joints," etc., etc.

This is the manner in which The Metalline Cement Co., 12, Bath Street, Glasgow, announce their remarkable goods, which I propose to make the subject of my present investigation.

Many instances occur in factories, and other industrial establishments, in which the application of such substances as those now being considered would prove of substantial benefit. Castings received may be found to contain small cavities, overlooked by the suppliers of the material, and it might be that the blemishes would not be important enough to call for the return of the metal to the foundry; yet be unsightly, and somewhat troublesome when the objects were put to their uses.

Loosened joints of various kinds, cracks in parts of machinery which do not seriously affect operations, but demand attention, and other circumstances are of common occurrence, and could be satisfactorily dealt with by means of the powders here described.

Of course, there are cases (for example, essential areas of boiler plates) when it would be wrong to attempt to correct them by these methods, as they would require replacement on account of safety. But where risks to life are not involved by adopting the products for purposes of improvements or repairs of the nature outlined, metal cements of this composition are of great value.

The sample of metalline cement with which I was kindly supplied by the manufacturers is a very fine, slaty-grey, heavy powder, known as Grade D. Other grades are obtainable, but this one was quite suitable and typical for my examinations, which were intended to convey to everybody interested in the

Iron Cements.—Fig. 1.

matter of iron and steel renovation the reason why these novel products could be effectively used in the direction stated.

When required for the filling up of holes, crevices, and so on, in appropriate metals, a portion of the powder is piled on a smooth, flat surface, and then mixed with water. Cans and similar utensils must be tabooed in this connection. I find that an earthenware tile is as handy as anything else, a knife-blade or spatula being the medium used for the blending.

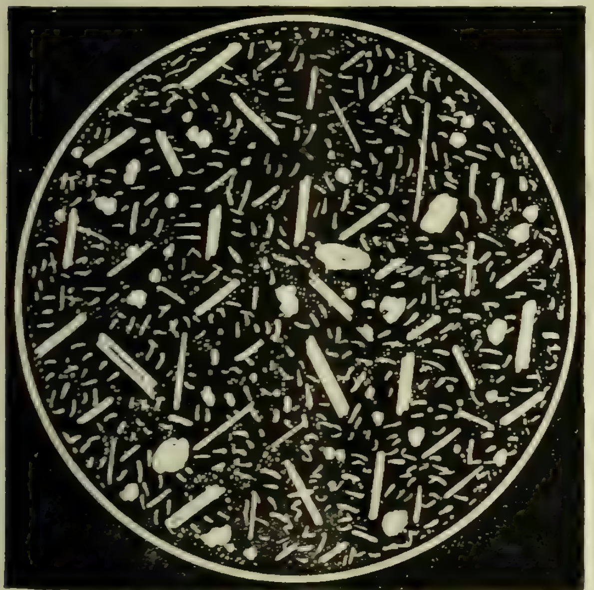
Great care is needed in the mixing, and only enough water to moisten the powder should be added to begin with, followed by more of both substances until a dark, putty-like paste is in evidence.

While the metal cement is still wet it exhibits a shiny texture, but during the subsequent drying process it loses this gloss and becomes dull. But it can be made to take a high degree of polish when it is thoroughly dry, just as though it was actual metal.

The substance soon hardens, and a half-hour or so

after it has been a mere paste it is dense enough to withstand strong pressure from a finger-nail without showing any impression. Increase in hardness is continuous.

When the metalline cement and water are mixed together a curious contraction is obvious, the mass



Iron Cements—Fig. 2.

getting very much smaller than would be expected. This course of events is due partly to the concentrating action of the water, which exerts a suction upon the grains, and partly to the capillarity caused by the interstices between the grains. Particles which have hitherto lain flat or tilted irregularly against one another, thus having innumerable air-spaces between them, are readjusted into appropriate binding positions, while crystals of mineral matter (see later notes) are forced to occupy spaces which were previously full of air.

As the whole mass solidifies by the evaporation of water, recrystallisation of the particles into and among one another brings about a rigidity which is sufficient for the purpose indicated in my earlier remarks.

To observe and understand the actions referred to, you need only place a few drops of water together on a sheet of glass, and then push some powder against the margin. Immediately contact is made between solid and liquid; the latter sucks the former boldly into itself, as much as possible, and then travels between the adjacent grains in an attempt to drag them also up into one mass. Surface tension is responsible for this effect. This force is seen when drops of water fall from a tap, each one being contracted into a sphere through surface tension.

If a pile of powder is, instead, lain down, and some water is put against its margin, the liquid very soon disappears, having been drawn by the power of capillary attraction among the grains.

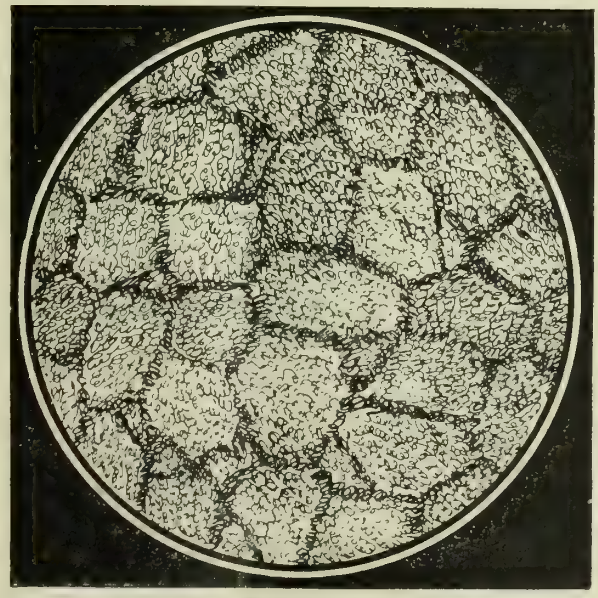
These two factors, by acting in mutual opposition, produce a stabilising result, which practically amounts to an agreement, as it were, or equilibrium. The grains of powder, in closing up tightly together, try to exclude the water; the water in trying to assume sphericity, consolidates the powder. Like Capital and Labour, each works for itself against the other; yet, finally, they settle down completely united in the correct proportions, to the advantage of the whole.

After this, the procedure in the metal cement is more obscure, and the microscope must be used if we desire to fathom its behaviour and structure. It is apparent, however that as it becomes drier a gradual hardness, increase of density, and general firmness is established in all parts, and the substance becomes really a piece of metal.

Upon examining the metalline cement microscopically, I learn that it is a powder consisting principally of grains of iron of varying sizes, all small so far as ordinary judgment is concerned, but ranging actually among themselves from relatively large angular particles to mere impalpable dust. Until the powder is wetted the grains are so thickly covered with the dust that they present a toothed appearance all round their contours, owing to the tiny specks adherent all over them, although they can only be seen in side view, where the light passes up round the grains while they lie on glass.

Minute, semi-transparent, colourless needle-crystals and grains are scattered among the dark, opaque ones, and I conclude that these are siliceous or flinty, as can be demonstrated by pouring some dilute acid over the powder, so that the grains of iron are dissolved, thereby leaving the grains of silica free, undamaged, and very plain.

To show that the dark grains are iron, I drop some dilute hydrochloric acid upon them, and after they are dissolved I add a small quantity of solution of ferro-cyanide of potassium (*i.e.*, yellow prussiate of potash) thereto. The instant appearance of a blue



Iron Cements.—Fig. 3

pigment proves the matter, this being Prussian blue, which is always formed by the compounding of iron and the acid and salt first named. It is an infallible test for iron. While there is no free carbon or graphite in the powder, some of this element must be in chemical combination with the iron.

In my experiments I deposited the dabs of paste prepared by mixing the metalline cement and water together on to a piece of glass, so that the exact formation of the grains could be ascertained by making direct microscopical inspection through the glass. I found that a very even, minutely-speckled, texture was conspicuous on this part, and it was just possible to detect the boundary spaces between the separate grains.

I later on pushed the solidified lump off the glass, and then saw that all over the latter were multitudes of exceptionally fine raphides, or spicular crystals, clear spaces between the clusters indicating the former positions of the grains of the metallic cement. The importance of this particular feature is explained elsewhere, so does not need further emphasis.

It is certainly surprising that a powder and water will yield a solid metal not unlike that obtainable from molten metal due to heat. But there are several almost inexplicable phases and activities between water and heat. Water will oxidise or rust iron; and so will heat. Other examples could be cited, but need not, since my reason for speaking of them is due to the fact that water and metalline cement, and heated molten metal, yield results which are not very dissimilar to each other. Both depend for their solidification on an internal process of crystallisation; yet water and heat have apparently no analogy with each other.

Sir Robert Hadfield, whose original invention, manganese steel, is probably the hardest metal in existence—our soldiers' "tin hats" or shrapnel helmets, railway layouts, shells, armour plate, etc., are made of it— said some time back, in a lecture: "The problems of the alloys of carbon and of many different elements with the world's leading metal—iron—are extraordinarily fascinating. . . . . It is constantly used for a variety of purposes; yet we all recognise that it still embodies a vast number of secrets—it still affords a wonderful field of research."

The illustrations will help the understanding of my notes. In No. 1 is shown a sprinkling of metalline cement lying on glass, up through which the light shines. All items are closely mingled together. In No. 2 is shown some of the powder, more thickly clustered, and lighted from above, thus disclosing the white mineral crystals and grains. In No. 3 is shown a view of the surface of the metalline cement after it has been mixed with water, and then dried hard. It will be seen that the iron grains have been so readjusted as to fit together correctly like mosaic, angles and sides being neatly joined. The interstices between the grains are filled up by the dust-like smaller particles, which bind the whole mass together.

Queensland's Largest Irrigation Scheme. Queensland is an important field for the activities of the artesian well engineer. The largest irrigation scheme in Queensland is now well under way at Inkerman, Burdekin delta. It is proposed to provide water for 50,000 acres of sugar lands. Plenty of water is available at shallow depths, and power from a central station is supplied, so that water may be lifted from wells on each property, or a number of associated properties. A modern sugar mill has been erected not far away. A demonstration farm is being established at Home Hill, on the area benefited.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Official Lecture: "The Screw Propeller."* By Peter Doig (General Secretary).

The paper is divided into three parts. There is a short section devoted to theory; a concise treatment of the screw's surroundings; and, at greater length, methods are given for obtaining the best dimensions to suit specified requirements.

For the quasi-theoretical needs of design and drawing offices the paper provides what is necessary. Much of the work is original, and the writer claims that the subject has not been so presented before. His is not so much an academic treatise as a practical guide in the technique of the designer's art. He indicates the authorities to whom the interested reader may turn for the elaborate and analytical discussion of the highly complex theory involved.

As typical of the method adopted there is the treatment of "the law of comparison." Upon this foundation monumental work of experts has been erected. Mr. Doig addresses himself to engineers, not to archæologists, however. Thus, a chart—legitimate offspring of theory wedded to practice—epitomises the salient features. This is characteristic of the paper. By means of valuable charts, diameters of blades, also propeller pitch, are readily obtained. This exemplifies yet again how judicious use of graphical constructions can frequently save page upon page of involved and often necessarily laboured prose.

Possibly a curve to replace the table wherein the author refers developed areas to D.R.$\frac{1}{4}$ might have been a gain.

The paper starts upon the historical note; it concludes with a prophetic vision of the wonders to be, and in process of becoming.

The lecture is eminently suited to the practical use of the technical engineer and designer. Those interested should take note.

Official Lecture: "Commutators as Structures."* By R. J. Roberts, A.M.I.E.E. (Member).

This paper follows in the wake of that read before the Institution of Electrical Engineers some years ago, and of later articles in the technical press.

The author's reference to this "somewhat condensed essay" is an apt one. No one can accuse him of meandering. To treat adequately of stresses in both vee and shrink ring commutators is no light undertaking. This has been done. Consequently, result succeeds result with greater rapidity than the mere tyro way readily assimilate. With such a programme, however, this is inevitable.

There are the various copper, mica, and ring and bolt stresses. In the last, Mr. Roberts breaks up new ground. The application to the shrink ring structure follows roughly the same order as that for the vee ring type.

In one or two instances, where it is customary to adopt purely empirical methods, the writer seeks to refer his assumptions to first principles. That is excellent. He would be the first to admit, however, that his is the initial not the concluding stage of a process. Experimental research work should second his efforts.

It is probably arguable that in the shrink ring construction the worm bar between rings may be regarded as somewhat analogous to a fixed support system. In that case the greatest stress, especially if the end cone be a long one, may occur at the hither end of the first span. It might be well, at least where stresses run high, to compare the result so obtained with that derived by means of the assumption made in the paper.

If one may pick midst choice fare, the preference is for the parts dealing with the technique of construction. The author's plea that those responsible for delicate and exceptional features of design issue firm and clear instructions to the shops respecting the necessary processes involved is entirely and heartily endorsed. We are too slack. Whose habit is a trust to chance invite mischance.

Perhaps, if permitted to do so, at some future date Mr. Roberts might consider extending his work to embrace the famed radial surface construction type of commutator. This by way of bait.

The paper is one which engineers in general, electrical engineers particularly, should read with interest and profit.

* Price: To members, 1s. each; to non-members, 2s. each.

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 62 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 2 4	11 0 8	0 16 2 12	1 2 0 16	1 7 2 20	1 13 0 24	1 18 3 0	2 4 1 4	2 9 3 8	0
1	0 2 6	6 0 10	11 2 14	0 17 0 18	1 2 2 22	1 8 0 26	1 13 3 2	1 19 1 6	2 4 3 10	2 10 1 14	1
2	1 0 12	6 2 16	12 0 20	0 17 2 24	1 3 1 0	1 8 3 4	1 14 1 8	1 19 3 12	2 5 1 16	2 10 3 20	2
3	1 2 18	7 0 22	12 2 26	0 18 1 2	1 3 3 6	1 9 1 10	1 14 3 14	2 0 1 18	2 5 3 22	2 11 1 26	3
4	2 0 24	7 3 0	13 1 4	0 18 3 8	1 4 1 12	1 9 3 16	1 15 1 20	2 0 3 24	2 6 2 0	2 12 0 4	4
5	2 3 2	8 1 6	13 3 10	0 19 1 14	1 4 3 18	1 10 1 22	1 15 3 26	2 1 2 2	2 7 0 6	2 12 2 10	5
6	3 1 8	8 3 12	14 1 16	0 19 3 20	1 5 1 24	1 11 0 0	1 16 2 4	2 2 0 8	2 7 2 12	2 13 0 16	6
7	3 3 14	9 1 18	14 3 22	1 0 1 26	1 6 0 2	1 11 2 6	1 17 0 10	2 2 2 14	2 8 0 18	2 13 2 22	7
8	4 1 20	9 3 24	15 2 0	1 1 0 4	1 6 2 8	1 12 0 12	1 17 2 16	2 3 0 20	2 8 2 24	2 14 1 0	8
9	4 3 26	10 2 2	16 0 6	1 1 2 10	1 7 0 14	1 12 2 18	1 18 0 22	2 3 2 26	2 9 1 2	2 14 3 6	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 5·17	0 10·34	0 15·51	0 20·68	0 25·85	1 3·02	1 8·19	1 13·36	1 18·53	1 23·70	2 0·87	2 6	

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 62 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	.	2 15 1 12	5 10 2 24	8 6 0 8	11 1 1 20	13 16 3 4	16 12 0 16	19 7 2 0	22 2 3 12	24 18 0 24	0
10	0 5 2 4	3 0 3 16	5 16 1 0	8 11 2 12	11 6 3 24	14 2 1 8	16 17 2 20	19 13 0 4	22 8 1 16	25 3 3 0	10
20	0 11 0 8	3 6 1 20	6 1 3 4	8 17 0 16	11 12 2 0	14 7 3 12	17 3 0 24	19 18 2 8	22 13 3 20	25 9 1 4	20
30	0 16 2 12	3 11 3 24	6 7 1 8	9 2 2 20	11 18 0 4	14 13 1 16	17 8 3 0	20 4 0 12	22 19 1 24	25 14 3 8	30
40	1 2 0 16	3 17 2 0	6 12 3 12	9 8 0 24	12 3 2 8	14 18 3 20	17 14 1 4	20 9 2 16	23 5 0 0	26 0 1 12	40
50	1 7 2 20	4 3 0 4	6 18 1 16	9 13 3 0	12 9 0 12	15 4 1 24	17 19 3 8	20 15 0 20	23 10 2 4	26 5 3 16	50
60	1 13 0 24	4 8 2 8	7 3 3 20	9 19 1 4	12 14 2 16	15 10 0 0	18 5 1 12	21 0 2 24	23 16 0 8	26 11 1 20	60
70	1 18 3 0	4 14 0 12	7 9 1 24	10 4 3 8	13 0 0 20	15 15 2 4	18 10 3 16	21 6 1 0	24 1 2 12	26 16 3 24	70
80	2 4 1 4	4 19 2 16	7 15 0 0	10 10 1 12	13 5 2 24	16 1 0 8	18 16 1 20	21 11 3 4	24 7 0 16	27 2 2 0	80
90	2 9 3 8	5 5 0 20	8 0 2 4	10 15 3 16	13 11 1 0	16 6 2 12	19 1 3 24	21 17 1 8	24 12 2 20	27 8 0 4	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	27 13 2 8	55 7 0 16	83 0 2 24	110 14 1 4	138 7 3 12	166 1 1 20	193 15 0 0	221 8 2 8	249 2 0 16	276 15 2 24	

COMPILED AND ARRANGED BY T. F. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 61 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 1 22	10 3 16	0 16 1 10	1 1 3 4	1 7 0 26	1 12 2 20	1 18 0 14	2 3 2 8	2 9 0 2	0
1	0 2 5	5 3 27	11 1 21	0 16 3 15	1 2 1 9	1 7 3 3	1 13 0 25	1 18 2 19	2 4 0 13	2 9 2 7	1
2	1 0 10	6 2 4	11 3 26	0 17 1 20	1 2 3 14	1 8 1 8	1 13 3 2	1 19 0 24	2 4 2 18	2 10 0 12	2
3	1 2 15	7 0 9	12 2 3	0 17 3 25	1 3 1 19	1 8 3 13	1 14 1 7	1 19 3 1	2 5 0 23	2 10 2 17	3
4	2 0 20	7 2 14	13 0 8	0 18 2 2	1 3 3 24	1 9 1 18	1 14 3 12	2 0 1 6	2 5 3 0	2 11 0 22	4
5	2 2 25	8 0 19	13 2 13	0 19 0 7	1 4 2 1	1 9 3 23	1 15 1 17	2 0 3 11	2 6 1 5	2 11 2 27	5
6	3 1 2	8 2 24	14 0 18	0 19 2 12	1 5 0 6	1 10 2 0	1 15 3 22	2 1 1 16	2 6 3 10	2 12 1 4	6
7	3 3 7	9 1 1	14 2 23	1 0 0 17	1 5 2 11	1 11 0 5	1 16 1 27	2 1 3 21	2 7 1 15	2 12 3 9	7
8	4 1 12	9 3 6	15 1 0	1 0 2 22	1 6 0 16	1 11 2 10	1 17 0 4	2 2 1 26	2 7 3 20	2 13 1 14	8
9	4 3 17	10 1 11	15 3 5	1 1 0 27	1 6 1 21	1 12 0 15	1 17 2 9	2 3 0 3	2 8 1 25	2 13 3 19	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	5·09	10·18	15·27	20·36	25·45	1 2·54	1 7·63	1 12·72	1 17·81	1 22·9	1 27·99	2 5	

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 61 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 14 1 24	5 8 3 20	8 3 1 16	10 17 3 12	13 12 1 8	16 6 3 4	19 1 1 0	21 15 2 24	24 10 0 20	0
10	0 5 1 22	2 19 3 18	5 14 1 14	8 8 3 10	11 3 1 6	13 7 3 2	16 12 0 26	19 6 2 22	22 1 0 18	24 15 2 14	10
20	0 10 3 16	3 5 1 12	5 19 3 8	8 14 1 4	11 8 3 0	14 3 0 24	16 17 2 20	19 12 0 16	22 6 2 12	25 1 0 8	20
30	0 16 1 10	3 10 3 6	6 5 1 2	8 19 2 26	11 14 0 22	14 8 2 18	17 3 1 14	19 17 2 10	22 12 0 6	25 6 2 2	30
40	1 1 3 4	3 16 1 0	6 10 2 24	9 5 0 24	11 19 2 16	14 14 0 12	17 8 2 8	20 3 0 4	22 17 2 0	25 11 3 24	40
50	1 7 0 26	4 1 2 22	6 16 0 18	9 10 2 14	12 5 0 10	14 19 2 6	17 14 0 2	20 8 1 26	23 2 3 22	25 17 1 18	50
60	1 12 2 20	4 7 0 16	7 1 2 12	9 16 0 8	12 10 2 4	15 5 0 0	17 19 1 24	20 13 3 20	23 8 1 16	26 2 3 12	60
70	1 18 0 14	4 12 2 10	7 7 0 6	10 1 2 2	12 15 3 26	15 10 1 22	18 4 3 18	20 19 1 14	23 13 3 10	26 8 1 6	70
80	2 3 2 8	4 18 0 4	7 12 2 0	10 6 3 24	13 1 1 20	15 15 3 16	18 10 1 12	21 4 3 8	23 19 1 4	26 13 3 0	80
90	2 9 0 2	5 3 1 26	7 17 3 22	10 12 1 18	13 6 3 14	16 1 1 10	18 15 3 6	21 10 1 2	24 4 2 26	26 19 0 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	27 4 2 16	54 9 1 4	81 13 3 20	108 18 2 8	136 3 0 24	163 7 3 12	190 12 2 0	217 17 0 16	245 1 3 4	272 6 1 20	

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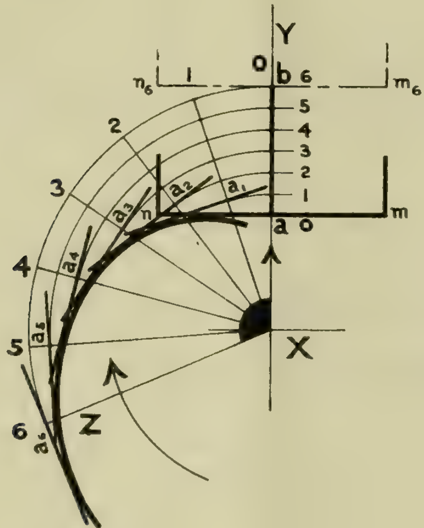
CAMS.

By W. E. Bennison, A.M.I.M.E.

(Continued from page 117.)

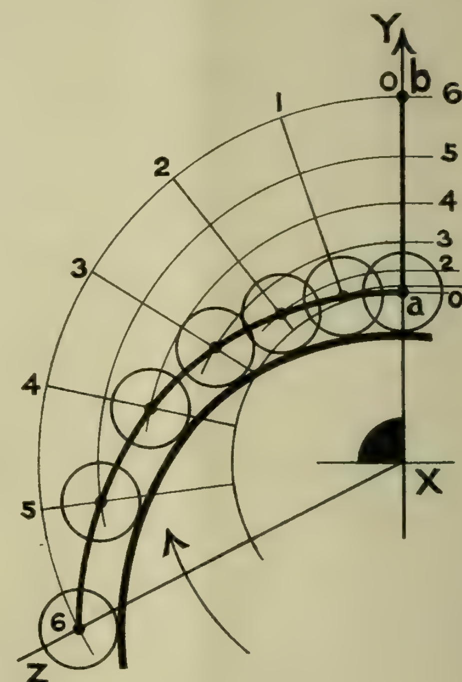
IV. Uniform velocity: surface contact; rectilinear motion.—The construction for this type is shown in Fig. 29. X is the axis and *m n* the surface of the actuated member in contact with the cam; Z X Y is the cam angle. The actuated member may be taken to be a sliding bar with the surface *m n* at right angles to the direction of motion, which is a common case. The line X Y is also drawn in the direction of motion and by the action of the cam in revolving through the angle Z X Y the surface *m n* is pushed in a direction X Y to the dotted position m_6 n_6: the distance between these two positions is the stroke of the follower. Following the principles laid down the follower path must be revolved round the point X; but there is no definite follower path because the surface is composed of an infinite number of points



CAMS.—FIG. 29.

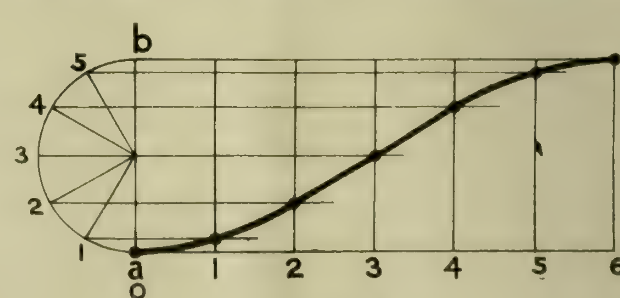
and these points move in an infinite number of parallel paths. However, it is possible to select one point, trace its motion, and then draw the surface in its correct relation to this point. The point *a*, which is the intersection of the lines X Y and *m n*, is the best one to take for this purpose. The motion of the point *a* will be in the direction X Y until it arrives at the point *b* at the end of its stroke: the line *a b* may therefore be taken as the follower path, and the surface will always be at right angles to it. If the line *a b* is revolved in an anti-clockwise direction exactly in the manner described in Case I. (Fig. 24) a series of radial lines will result, and these may be numbered, say, 0 to 6: following the same construction the line *a b* is divided into six equal parts, and each part on that line turned round by means of an arc into the radial line of corresponding number. The intersections thus found represent six new positions of the point *a*. In the diagram they are figured a_1 to a_6. Now at right angles to every radial line and passing through the position of point *a* on that line is drawn a line to represent the surface. Thus, six new positions of the surface are found. The true cam curve is a curve which touches all these straight lines; that is, every position of the surface is a tangent to the curve.

V. Harmonic motion: roller contact; rectilinear motion, direction passing through axis.—The method of setting out this type of cam curve is exactly as described in Case I. (Fig. 24) except as regards the spacing of the follower path. The lay-out is shown in Fig. 30, and the lettering is as before: X is the axis, Z X Y the cam



CAMS.—FIG. 30.

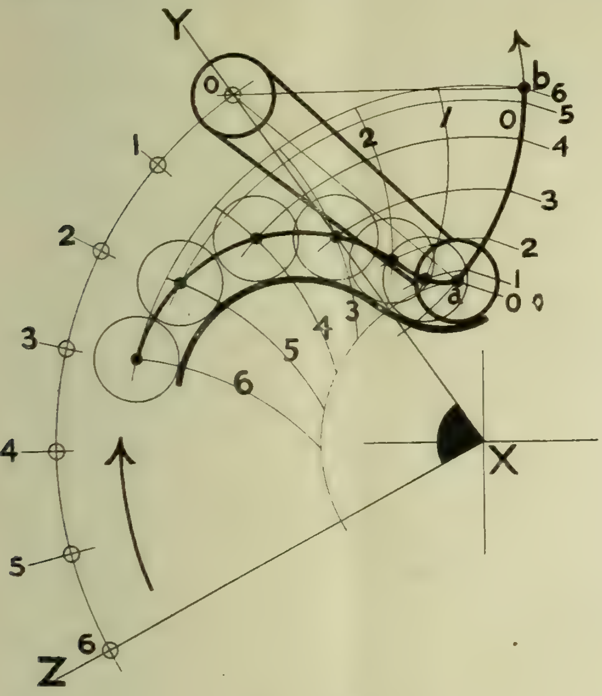
angle, and *a b* the follower path. As before, equidistant positions are found for *a b*, each position being a radial line. The dividing up of the follower path requires different treatment. The space-time or displacement curve is given in Fig. 31. As before, the abscissæ represent times and the ordinates spaces. The length of the diagram is equal to the circular measure of the cam angle and the ordinates are equally spaced, repre-



CAMS.—FIG. 31.

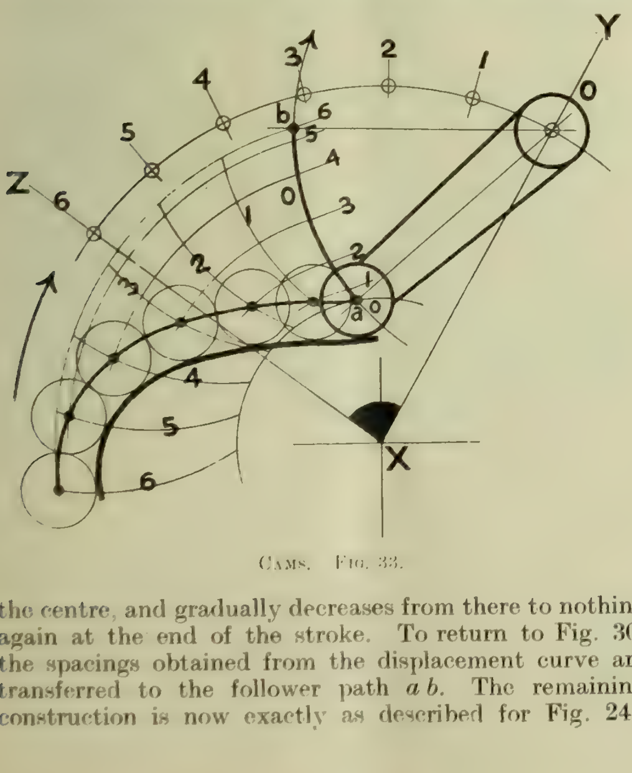
senting equal movements of the cam. The height of the diagram is equal to the length of the follower path *a b*. The motion of the point *a* along *a b* is to be harmonic; and a curve must be plotted to give harmonic motion. Such a curve is a sin curve. The construction is simple. At one end of the diagram a semi-circle is described, having a diameter equal to the total height of the diagram: this semi-circle is divided into any

number of equal parts; in this case six divisions are taken and the points are numbered 0 to 6. Through every point on the semi-circle a line is drawn parallel to the base line to meet the ordinate of corresponding



CAMS.—FIG. 32.

number: thus, through point 1 on the semi-circle a line is drawn to cut ordinate 1; through point 2 on the semi-circle a line is drawn to cut ordinate 2; and so on. Through the intersections thus obtained the curve is drawn. It is observed that the slope of the curve, and therefore the velocity, increases gradually from nothing at the commencement of the stroke to a maximum at



CAMS.—FIG. 33.

the centre, and gradually decreases from there to nothing again at the end of the stroke. To return to Fig. 30, the spacings obtained from the displacement curve are transferred to the follower path $a\,b$. The remaining construction is now exactly as described for Fig. 24; arcs are drawn through all the points on $a\,b$ to cut the various follower path positions. The resulting intersections give the positions for the roller centre.

It will have been remarked that in this particular case there really was no need to draw the displacement curve and that the semi-circle could have been directly described on the line $a\,b$. This is so, and in many cases the displacement curve can be dispensed with.

VI. Harmonic motion: roller contact; angular movement.—In this case, as in Case III. (Fig. 28), the roller is carried by the free end of a lever. The description given for Case III. will apply here, except for the spacing of the points in the follower path. Two examples are shown for this type. In every respect but one these two diagrams are similar. The cam angle, the length of the lever, the distance of the fulcrum from the axis, the length of the follower path, and the distance of the roller centre from the axis, are the same in each case. The only difference is that the two levers are placed opposite hand to each other: in Fig. 32 the roller lifts slightly in the direction in which the cam is moving; in Fig. 33 the roller lifts in a direction slightly opposite to the cam's motion. This difference will affect the shape of the curve, as a glance at the diagrams will show. The lettering is the same for both figures and the same description applies to both. X is the axis, Z X Y the cam angle, a the centre of the roller, and the circular arc $a\,b$ the follower path. Adopting the former construction, the line X Y is made to pass through the fulcrum. The fulcrum is moved through the angle Y X Z and equidistant intermediate positions found for it. From every fulcrum position an arc is described having a radius equal to the length of the lever. The arcs are given the same numbers as the centres from which they are struck. The follower moves along the arc $a\,b$ with harmonic motion, and to obtain the correct spacing of the points reference is made to Fig. 31. The arc is flattened out into a straight line, and this straight line is equal to the height of the diagram. It is obvious that in this case the semi-circle cannot be drawn on the follower path, and it is necessary to construct a displacement curve. The spaces obtained from this curve must be transferred back to the follower path (Figs. 32 and 33), and they represent arcs. The rest of the construction follows the previous description. Through every point on $a\,b$ an arc is drawn cutting the corresponding follower path position. The points of intersection give the centres for the roller, and the actual cam curve is drawn to touch the roller circles.

(To be continued.)

Mr. M. D. Jones, who has had many years practical experience in the design and erection of Fuller-Lehigh cement plants, pulverised coal installations and mills, and who has specialised in the application of pulverised fuel to all kinds of furnaces in the iron and steel industries, will be attached to the London office of the Fuller Engineering Co., as from January, 1920. Mr. Ernest E. Noble (late of the Stirling Boiler Co. Ltd.) has joined the Fuller Engineering Co., and will give his special attention to the application of pulverised coal to boiler plants and locomotives. Mr. H. W. Portas, late Superintendent Engineer for the Ministry of Munitions, Machine Tool Section (aero engine production), who has had a wide experience abroad in the erection and operation of mining plants, will handle all matters connected with plant equipment. Expert advice and assistance of experienced engineers will therefore be available on all matters connected with pulverising equipments, cement plants, and pulverised coal applications, on application to:—The Fuller Engineering Co., 25, Victoria Street, Westminster, London, S.W.1.

THE CASE OF THE EX-OFFICER.

No problem connected with the resettlement of the country after the war is more difficult than that presented by the ex-officers and men of higher education who have been demobilised and are now looking for work. Two-thirds of them at least are of the clerical type, that is to say, the work for which they are fitted is business or professional work, as distinguished from ordinary industry, and it is not fair to expect them to take up any other. Many of them, perhaps most, have when the call came to them, given up either good prospects or positions which, if not highly lucrative at the time, would by this, given ordinary good luck and attention to business, have led to others suitable to men of the age they have now attained. Behind these men is, however, the handicap of four, or in some cases, even five years' service in the field, during which they certainly have had no leisure to make progress in the work to which they hoped and expected to return. Many of them married on the strength of their promotion, and require an income which will allow them to support a wife and family. Altogether it will be seen that the position is not an easy one, and that these men, besides deserving of the help which can be given them, require it if they are to make good.

The King has expressed the keenest interest in the problem which they present, and the Ministry of Labour has worked out a scheme by which those who have stopped on the brink of a University career or have only just embarked on a profession, receive an intensive course of training, and in certain cases, grants for maintenance and for fees from the State. Between eight and nine thousand young men have been placed in training by the Appointments Department, which has this matter in hand, apart from those who have been referred to the Boards of Education and Agriculture. With regard to actual appointments, which are, of course, the urgent need of slightly older men of similar standing, Sir Robert Horne has made a strong appeal to employers to help in putting these applicants also in the way of earning their living. A great deal has been done already, despite the four blank years during which they have lost ground in their businesses and professions, or become unfit to follow their former occupations, and posts have been found for about 17,000.

But there are at least twenty thousand more still in want of work, and the number is continually being added to as demobilisation proceeds. Employers are asked to make some small temporary sacrifice for their sake, give individual help and show individual sympathy, and not to shrink from the expense of providing them with the means of livelihood while they are adjusting themselves to conditions which must at first be comparatively strange to them while they are qualifying themselves for the positions they will eventually be able to fill. It is not very much to ask. If these men had not answered the call, if they had not done their duty, and much more than their duty, the employers who are now called upon to help them would not have been able to help even themselves. It would not have been a question whether their businesses would run smoothly or not, but whether they would run at all. To put it in common language, they would not have been left a feather to fly with, and they owe a very great debt to the men who have helped to save them from this fate.

Putting it upon the lowest grounds, it would pay them to discharge it. Brains are not so common an asset that business men can afford to disregard them, and these men have been taught to use theirs, both by the higher education they have received before they went out to fight and the experience they have gained in the field. For the man who has learned how to outwit the Boche there must be a place in some great business house which desires to conquer fresh fields of enterprise, or which even hopes to hold its own in the keen competition of to-day. Such a man has doubtless lost something by his service in the field, but he has infallibly gained a great deal more than he has lost. He comes back to business with habits of discipline ingrained in him and with powers of initiative immensely developed. He has learned how to handle men, both those above him and those below him, and he has been continually driven by every recurring emergency to rely upon his own resources. Moreover, from some points of view at any rate, it is probable that he comes back a better man at business than when he left. An officer is not always fighting; indeed, a battle is, comparatively speaking, an infrequent incident, even in such a war as that through which we have lately passed. The greater part of his work is business in the strictest sense of the term, and business often of the most highly complicated kind. He has had to make reports on all sorts of subjects, knowing sometimes that the lives of many men, and perhaps even the safety of a division, may depend on the accuracy and the skill with which the facts are presented. He has had to learn both how to interpret orders received and how to give orders to others in terms which admit of no mistake. He has had to handle large sums of money and claim allowances for all kinds of complicated things, to be always cool and always cheerful, and to be the tactful intermediary between his superiors and subordinates.

If a man has done well in the war and has won promotion, depend upon it that he has not gained it by bravery alone, but by exactly those qualities which, when developed in any sphere, make the successful man of business. On the other hand, even a man with these qualifications must not look too high at first. He may have been drawing a colonel's pay and allowances while on active service, and, if he has, it is certain that he has earned them. But he cannot expect to jump at once into a mercantile position which would be an equivalent of that which he has held in the Army. Even with the most sympathetic and grateful employer he must take some time to prove himself, and he should realise that in the actual business he proposes to enter he cannot at once be worth so high a salary, though he may confidently hope to obtain one much higher later on, if he does as well as he has every right to expect.

The Appointments Department has its local Directorate now at 4, Cathedral Gates, Manchester. One of its main objects is to bring candidates for posts and employers together, and it is hoped that not only ex-officers and men of higher education in search of appointments will apply to it, but also employers in search of such men.

ALUNDUM GRAIN FOR POLISHING INNER TUBE MANDRELS BEFORE SHERARDISING.*

By C. L. Shaw.

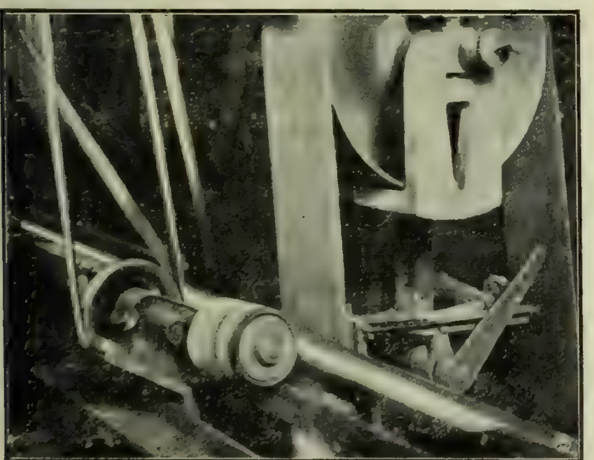
It is only within a few years that the application of zinc to other metals to produce a rust-proof surface by a process now known as "sherardising" has become a vitally important factor in the production of rubber inner tubes for pneumatic tyres. The New Haven Sherardising Co., of New Haven, Conn., in whose plant the following information was obtained, was the first concern to use this process in the treatment of tube mandrels, producing the first lot only five years ago.

The results obtained were so satisfactory that further experiments were carried on, and to-day the sherardised mandrel is used by practically every manufacturer of inner tubes in the country.

The process of sherardising is not merely the applying of a coating of zinc to another metal, as in galvanising, but it is a process whereby zinc in the form of fine dust penetrates into the pores of the metal for a distance of five to eight thousandths of an inch, and forms an alloy with the base. The zinc dust used in this work is of special manufacture and contains about 85 per cent pure zinc. It is obtained from the hoods of zinc smelters where it is formed by the condensation of zinc vapours, and is bolted through a very fine mesh screen.

Sherardising is not confined to the treatment of tube mandrels, which are discussed in this article, but has already proved a success on nails, bolts, screws, trolley fixtures, chains, and other such articles.

These tubes as they are received at the sherardising plant are the very highest grade of cold-drawn



Polishing by Means of a Belt Coated with Alundum Grain. This Operation Takes Place Before the Process of "Sherardising."

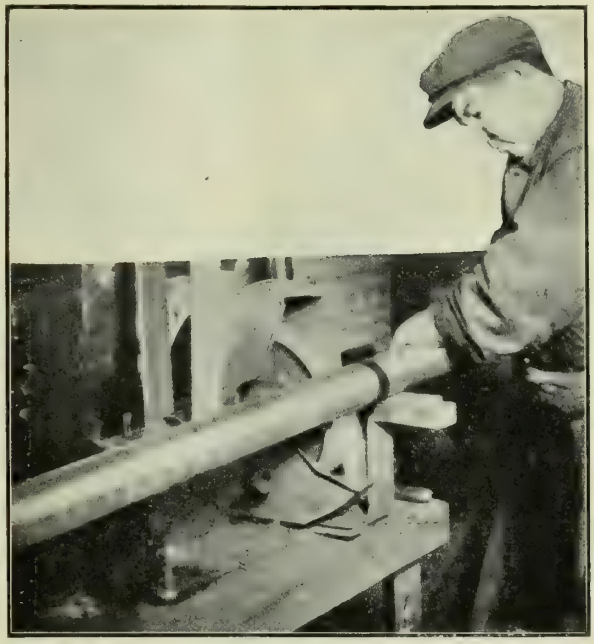
seamless Shelby steel tubing, in 10-ft. lengths and ranging from $\frac{1}{4}$ in. to 12 in. outside diameter.

They must be cleaned and polished before going to the treating ovens, and Alundum grain is used for this work in each of the six polishing operations.

* *Grits and Grinds.*

The rough mandrel is first cleaned on a Blevney automatic polishing machine, using a 14-ft. endless belt, 6 in. wide, and coated with number 36 T. J. Alundum grain. The belt runs at 5,400 surface feet per minute, the work at 160 to 200 revolutions per minute, and a 10-ft. mandrel passes through the machine in one minute.

From this machine the mandrel goes to a polishing wheel, size 12 by 3, which is set up with a combina-



The Mandrel is Fed Along the Wheel by Hand —the Second Operation.

tion of 36 and 46 T. J. Alundum grain and makes a speed of 3,200 revolutions per minute or 10,000 surface feet per minute. Here the work is fed along the face of the wheel by hand and is slowly rotated at the same time, making a long spiral cut the entire length of the mandrel. Whenever a hollow or dent appears, the operator stops the forward feed and works the hollow spot on the wheel for a moment in order to remove any foreign matter or rust that was not taken off by the first operation.

They go next to the polishing machine and are given four passes on Blevney automatic machines, each pass using a finer abrasive—36, 46, 70, and 100 T. J. Alundum grain respectively. The first pass is made with a work speed of 160 to 200 revolutions per minute and the last three with a work speed of 350 to 400 revolutions per minute, in all cases the belt running at 5,400 surface feet per minute.

The mandrels are now ready for treatment and are sent directly to the sherardising ovens where the zinc dust alloys itself with the steel and gives a zinc alloyed coating. From the treating ovens the mandrels go back into the shop and are given a very high polish.

All the way through, Alundum grain is used in preparing the material for sherardising, and the excellent results obtained furnish another instance where it has proved satisfactory for both free-hand and automatic polishing.

THE NATIONAL ROLL.

The hospitals are still discharging disabled ex-Service men—men, that is, whose disability is for the most part simply military, and who, if they are given the opportunity, are quite able to earn their own living in various walks of life. It does not follow, in fact it very rarely happens, that because a man is no longer fit to be a soldier he is incapable of resuming his old trade; still more rarely does it occur that the man who is both disabled in the military sense, and disabled so far as his own trade is concerned, cannot be provided for in a new one in which he can give every satisfaction to his employer, and earn for himself as good, or perhaps even a better, livelihood than that which he sacrificed when he went out to fight. It is a question of fitting the man to the job and the job to the man, and with care and consideration there are very few cases in which it cannot be done.

In September last a great appeal was made, led by the King, to employers to help in the solution of the problem. They were asked to provide employment or to keep vacancies open for disabled ex-Service men to the extent of an agreed percentage of their staffs. Those who gave the requisite undertaking became entitled to use the Seal of Honour, which signified to all that they had recognised the claim that these men have upon us all, and were doing their part to meet the sacred obligation. Further, their names were inscribed upon the National Roll, the first edition of which is to be published in the beginning of the New Year. It will interest most people to know that when the Roll appears it will be found to contain ten thousand names, names of great firms and of small ones, of public bodies and of single individuals. It will be a very noble record of gratitude and patriotism, redounding highly to the credit of British employers as a class.

But the hospitals are still discharging, and it is hard to keep up with the continual flow of disabled ex-Service men, nearly all perfectly competent to do a full man's work, and all not merely willing, but eager to have the chance of doing it. Consider what the situation really is. A reabsorption into industry has occupied the best efforts of the Labour Ministry, with the assistance of all those employers who have realised how imperative it is that the process should be hastened to the utmost extent. But at the moment of writing these lines, there are still about forty thousand of the disabled men unplaced—and the hospitals are still discharging. It is almost an Army in itself. It is larger than the armies employed in the "little wars" in which from time to time we used to be engaged, and which we thought of vast importance before the Great War came to dwarf all previous experience. It is just about the size of the army which we sent to the Crimea, and it has just as great a claim upon us as the forces which furnished the heroes of Balaclava and Inkerman. And it is continually being added to. Every week the hospitals discharge as cured, but disabled, hundreds of men to take the places of those for whom employment has been found.

There is need of a great effort, and it can only be made by the employers themselves. All that can be done in the way of creating machinery for training men who have become unfit for their own jobs to take up new ones, and for bringing together the employer who wants a workman and the workman who wants the sort of work he has to give, is being done. It would be easy for anyone conversant with the facts to fill pages with the mere enumeration of the different trades in which places have been found for disabled men, trades in which the man's disability has proved no hindrance to his work. But there is more, much more, still to be done. Despite the numbers on the National Roll, there must still be many employers who could win the right to have their names upon its pages, and have not yet done so. Very often one may well believe the neglect is due to mere thoughtlessness, but the feeling that what is everybody's business is nobody's business, and that in so large a matter there will be plenty to do all that is required. Plenty of people never realise that there are only a thousand ones in a thousand, and that they themselves count one. It is only by each man doing his own part, and not being content to hope that the other nine hundred and ninety-nine will do their part, that this or any other great enterprise can be brought to a successful issue.

If you are an employer, ask yourself whether your name will appear on the National Roll when the New Year opens, and if not, how can you honestly justify the omission to yourself. We know very well what would have happened if these men who have been disabled in the service of the country had refused to do their duty. The victorious enemy would, to use the words of that great German statesman, whom all German statesmen and soldiers accept as their examplar, "have left us nothing but our eyes to weep with." To save us from that fate these men did their part, and were broken in the doing of it. We owe them a duty which we can never pay in full. Is it too much to ask that those who can at least discharge some part of it should gladly embrace the opportunity?

It is a bitter and a cruel thing that any disabled ex-Service man, conscious of ample capacity to do a good day's work, should be allowed to feel that no one wants him after all he has done and all that he has suffered in the common cause. It is very hard to believe that any large employer of labour cannot find places for such men, and it is still harder to get the men themselves to credit it. Even on the lowest grounds, and setting all feelings of gratitude and patriotism aside, the thing is worth doing. The Government have made provision against any extra risks the employer may run by taking disabled men into his employment; the method of adopting the scheme is simplicity itself, all that is necessary being an application to the nearest Employment Exchange. The appeal is still made, the emergency is still with us, and the National Roll is still open. Who will refuse to sign?

The Institute of Metals. A useful card, showing dates and subjects for the forthcoming meetings of the various local sections of the above Institute, has just been published. The membership of the Institute is now over 1,200. Mr. Shaw Scott, the Secretary, at 36, Victoria Street, S.W.1, has received so many applications for membership that the forthcoming ballot on March 3rd is likely to constitute a record. A new illustrated membership booklet can be had upon application being made to the above address.

MODERN MACHINE SHOP PRACTICE AND THE LIMIT GAUGE SYSTEM.

By M. Coronel.

Modern workshop practice and methods of manufacture demand an entire revolution from the workshop and drawing office practices prevailing 30 years ago, and still existing in many of the older present-day workshops. This is largely due to the shortsightedness of the principals in many cases, and to other causes which have failed to impress the management with the necessity for departing from the antiquated methods, or the lack of any method at all. This is more especially true in workshops which specialise in the manufacture of any article or series of articles in a repeated or manifold form, whether in large or small quantities. The essentials of manufacture on modern lines are both to cheapen and improve at the same time, and to provide for interchangeability, either for replacement of worn-out or broken parts, or for the purpose of quick assembling. The direct results of these rules as laid down above would be, that the various parts of a machines could be standardised throughout the various series and sizes, more especially the smaller parts, which should be made for stock and be interchangeable within limits. This cheapens the cost of production and ensures interchangeability. To be able to accomplish this, various factors should be introduced into the process of manufacture which are non-existent in older shops.

These are: (1) Modern machinery specialised for the various processes in hand; (2) working to limit gauges; (3) almost total elimination of the one-time fitter with file, scraper, calipers, etc.; (4) an organised inspection department; (5) an efficient tool and gauge department.

We will now take the various changes which may be effected in an old-fashioned shop, or the building of an entirely new shop on these modern lines in the consecutive order as indicated above.

(1) Of modern machinery there ranks instead of the old-fashioned drilling machine used for all purposes, the gab lathe and shaft turning lathe, with old-fashioned slotter and planing machine, machines each having their own special use and capacity. Amongst the foremost of the modern lathes are these variable speed driven all gear lathe for chucking and plain turning, the modern variable speed shaft centre lathe, the turret lathe, the automatic and semi-automatic turning turret and ordinary lathe for small repetition work. Then follow the shaping, planing, keyway slotting and milling machines, the horizontal milling machine and the vertical milling machine. Further, the modern drilling machines used for accurate drilling, tapping and reamering with automatic stop action for the two latter operations the radial drilling machine, the sensitive drilling machine, the multiple spindle drilling machine. We find further, the various kinds of boring mills, as the horizontal boring mill, the vertical boring mill, the duplex vertical mill, large horizontal boring mills for turning and boring large flywheels, generator yokes and other large circular castings. A machine of essential modern invention is the modern grinding machine, as quite apart from the old-fashioned grindstone solely used for grinding tools, and these grinding machines are divided into grinding attachments of various kinds, for attachment to lathes and grinding machines proper, as round grinding machines, surface grinding machines with or without magnetic table to hold the work down, disc grinding machines, internal grinding machines, and various kinds of special automatic grinding machines for grinding special tools as twist drills, cutters of various kinds, and turning tools, broaching machines and screwing machines. Further can be mentioned, machines consisting of an iron vertical disc covered with grinding material such as carborundum, emery or glass paper for polishing purposes, and the modern buffing machines to give certain unessential but visible parts a polished finish. It will be found that the slotting machine has not been mentioned, and except for a small key seating slotter, the old-fashioned slotter has almost disappeared from modern machine shops as being too slow and wasteful in its operation. Certain minor machine tools have not been mentioned, but those enumerated are the principal ones now found in a modern equipped machine shop.

(2) We now come to the most important part of modern shop practice, and that is the working to an approved system of limit gauges. These being quite distinct from other and older forms of gauges, a component part consisting always of two distinct parts one of which is just a fraction too small to go on the part in hand to be finished, and the other part just large enough to go over or in the part to be measured within certain limits to be described later. To this rule there are one or two exceptions which will be dealt with later on. We therefore see that the modern system of measurement is a dual one, a kind of differentiation between a limit which will not go on the part to be measured and which is called the "lower limit," and a limit which will slip on and is called the "higher limit." It will therefore be seen that the old method of measuring with a pair of calipers to a fixed and set dimension is done away with, as this method leaves too much latitude to the workman, and the accuracy of the job depends entirely upon how easy or stiff he allows the calipers to slide on the part in hand, thus making it impossible for him to work to the limits fixed by the drawing office.

The adoption of a limit gauge system, and the practice of working to this is, therefore, to define with absolute certainty the permissible margin of error from the nominal size in workshop production.

The advantages of using the limit system are many, and soon outweigh the initial expense of installation. It ensures precision of manufacture without any greater skill and time on the part of the workman, reduction of time to produce, interchangeability of parts, quick replacement in case of breakdown, ability to make for stock and subsequent curtailment of delivery time, curtailment of wasters, and the almost cutting out of the fitter's department. The field of application of the limit system is by no means so restricted as some imagine, and that it can only be profitably employed on repetition work is incorrect; equal benefit may be derived from their use upon work not produced in quantities.

There are two main systems of limit gauging; one which makes the hole as near as possible to standard size, and makes the various allowances on the shaft. This is called the "hole system," and the other is the "shaft system," which makes the shaft as near as possible to the standard size and allows the various fits on the holes. Each of these systems has certain advantages. The "hole system" has the advantage, that holes are very often bored or drilled, and afterwards reamered with a standard reamer to a standard size, and that the various fits can be easier allowed and measured on a shaft than a hole.

The shaft system has the advantage that on a long plain shaft turned to standard size, parts can be fixed and fitted, requiring various fits, *i.e.*, one part pressed on, the next piece with a push fit, and still another with a running fit as shown in Fig. 1. However the "hole system" has found most favour in this country, and will be described in the following. There are three distinct notations to every gauge size, viz., (1) the nominal size; (2) the allowance; (3) the tolerance.

The *nominal size* is of course obvious.

The *allowance* is the necessary difference in the sizes of two pieces, so that they may go together with the particular quality of fit required.

The *tolerance* is the margin within where the work can be allowed to differ from the nominal size to allow for the unavoidable imperfections of workmanship.

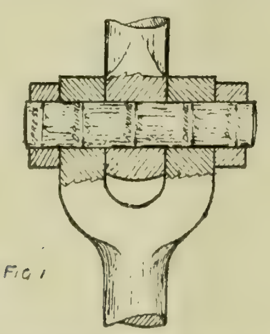


FIG 1

MODERN MACHINE SHOP PRACTICE.—FIG. 1.

This latter dimension is contained within the limits of the "go" and "not go" fit of every gauge used, and which is a constant limit for a certain size.

The first is a limit which varies with the size and the kind of fit required. The term "limits" is used both for the "tolerance" and the "allowance," and is in each case the top and bottom figure allowed for or allowable to be worked to. For the purpose of fitting two parts together for the work required, the various qualities of fits are divided in the following grades.

Holes are made nominally standard, but have two grades of "tolerances," one within fine limits generally called an "A" hole, another within coarser limits called a "B" hole. The "allowances" for the various working fits of the shaft are: force fits, generally called "F" fits; shrinking fits, generally called "S" fits; driving fits, generally called "D" fits; push fits, generally called "P" fits. Running fits, having generally three different grades, the coarsest called "X" fit; medium called "Y" fit; finest called "Z" fit. Some firms have three classes of driving fits, viz., light drive fit, called class "J," suitable for ball-bearing journals when not locked in position; medium drive fits, class "M," suitable for shafts of small gear wheels, couplings, etc., which can be tapped in position with a hammer blow; and the ordinary "D" fit named above.

Shafts requiring hydraulic or screw press pressure to force into their holes, or the holes required to be expanded by heat to shrink them on the shaft, are made to force fits or shrink fits. The various running fits are usually required as follows: class X, suitable for engine and other work where easy fits are required, or the bearing is liable to rise in temperature; class Y, suitable for high speed and average machine work; class Z, suitable for fine tool and instrument work.

(To be continued.)

GOVERNORS AND GOVERNING MECHANISM.

By A. HOULSON.

(*Continued from page 111.*)

Quantity Governing.

By this method the variation of the working charge is effected by varying its mass, the proportion of fuel to air in the entering charge remaining constant. The reduction in the mass of the charge at light loads causes a reduction in the compression pressure, and hence the thermal efficiency is lowered. This difficulty may be largely overcome by using higher compression pressures throughout.

By so doing more rapid and complete combustion is effected, and increased economy attained. This system of governing is deservedly popular, the defects of pre-ignition and excessive speed irregularity being noticeably absent.

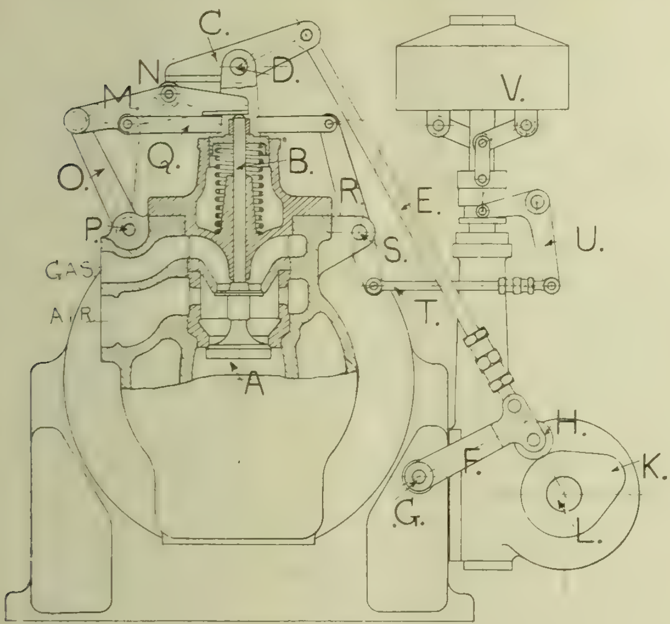
The method generally adopted in applying this system of governing to gas engines is by varying the instant of closing the inlet valve, and in oil engines by varying the stroke of the fuel pump plunger. Other methods are sometimes met with—*e.g.*, in gas engines the charge may be throttled throughout the whole of the suction stroke, and in oil engines part of the fuel may be forced back through a bye-pass valve into the suction side of the pump.

Fig. 73 shows the Tangye-Robson gas engine governor. This governor varies the extent of closing the inlet valve.

In the illustration the inlet valve is marked A and its stem is marked B. The lever C is mounted to turn on the fulcrum pin D, one arm of the lever being connected by the link E to the guide lever F, mounted to turn on a fulcrum pin G, and carrying a roller H bearing on a cam K on the shaft L. The slider M is interposed between the valve stem B and the arm of the lever C, opposite that connected to the link E. The slider M carries a roller N on which the arm of the lever C bears, one end of the slider bearing on the top of the valve stem B, and the other end being connected to a link O turning on a fulcrum pin P. The slider M is connected by the link Q with one end of the lever R, turning on a fulcrum pin S, the other end of the lever R being connected by the link T, with the bell-crank lever U operated by the governor V. If the engine be fully loaded, the slider M is moved by the governor V into such a position

(that shown in the drawing) that the roller N on it is at a maximum distance transeversely from a point in a line between the valve stem B and the fulcrum of the lever C, and thus the inlet valve A will be opened to its greatest extent. If there be less load, or no load on the engine, the slider M will be moved by the governor, so that the roller N is brought to a less distance transversely from the vertical centre line of the valve stem: or the roller may be brought directly beneath the fulcrum pin D.

Thus the operation of the inlet valve is varied by the action of the governor to an extent in accordance with the load, from full opening to no opening. In an example of this type of governor gear controlling the $6\frac{3}{4}$ in. diameter inlet valve of a $16\frac{1}{2}$ in. by 23 in. cylinder, the ratio of the movement of the governor sleeve to the movement of the link Q is 1 to 3. The force at the sleeve when the governor is in mid-position and running at normal speed is 660 lbs.



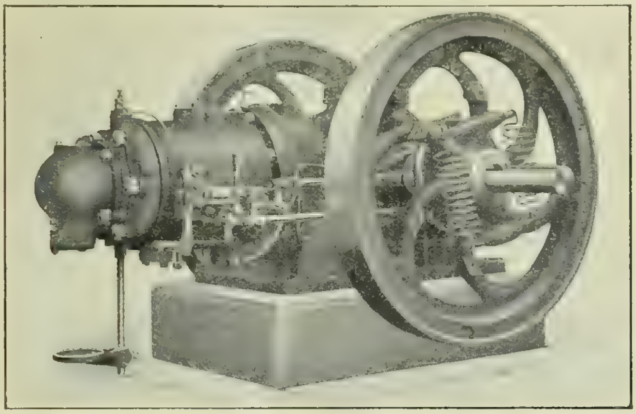
Governors.—Fig. 73.

Supposing, as in previous examples, a one per cent change in speed without movement of sleeve, we have:—

Controlling force on slider M $= .02 \times 660 \times \frac{1}{3} = 4.4$ lbs.

The Clayton oil engine governor is shown in Figs. 74 and 75. This governor alters the length of stroke of the fuel pump plunger to suit the load on the engine. The plunger is actuated by a quadrant through a pecker. A reciprocating movement—constant in extent—is given to the quadrant by a cam on the crankshaft. The position of the pecker on the arc of the quadrant regulates the amount of movement of the pump plunger, and therefore the amount of oil injected into the vaporiser. This position is controlled by the governor acting through a rocking lever.

The minimum movement is given to the plunger when the pecker engages with the quadrant at a point near to the fulcrum, and conversely, the maximum when the point of engagement is at the maximum distance from the fulcrum. By this means the movement of the pump plunger is varied from zero to maximum, and the consumption of oil fuel is regulated in proportion to the work done by the engine. The governor is of the spring loaded crankshaft type. The inner ends of the weight levers give a sliding movement to a sleeve on the crankshaft, which in turn, transmits this motion to the rocking lever referred to before.

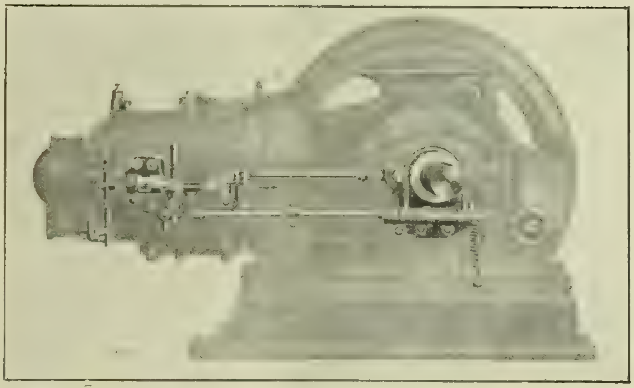


Governors.—Fig. 74.

The tension in the speed adjusting spring may be altered whilst the engine is running.

The 20 H.P. engine has a fuel pump plunger $\frac{5}{8}$ in. diameter. The governor weights are each 13.8 lb. (including weight of springs and clips), and revolve in a circular path of $7\frac{1}{4}$ in. radius at mid-position. The normal speed of the engine is 300 revolutions per minute. Consequently the centrifugal force of the two weights at normal speed = 510 lb. The ratio—

$$\frac{\text{Movement of governor weights at centre of gravity}}{\text{Movement of fuel pump plunger}} = \frac{\cdot 442}{\cdot 125} = 3\cdot 54.$$



Governors.—Fig 75.

The controlling force on plunger is therefore

$$.02 \times 510 \times 3.54 = 36 \text{ lb.},$$

or 58 lb. per inch diameter of plunger. (Note.—By movement of plunger is meant the difference in stroke of plunger at in and out positions of governor.) The governor is not necessarily obliged to operate against the plunger pressure, as the position of the pecker may be altered by the governor at the instant it is

disengaged from the quadrant, but this calculation forms a convenient basis for design.

The main and adjusting springs for this governor are calculated in exactly the same manner as described in the instalment of this article, which appeared in the issue of this journal for November 22nd, 1918.

(To be continued.)

INSTITUTION OF AUTOMOBILE ENGINEERS.

The fifth ordinary general meeting of the session of the Institution of Automobile Engineers was held on Wednesday, January 7th, when Lieut.-Colonel D. J. Smith read a most interesting paper on "The Use of Producer-Gas for Motor Vehicles." The subject is one of pressing importance to-day in view of the urgent need of increased transport and the necessity for the utmost economy in its use. A point of particular importance brought out in the paper was the great variety of fuels which can be used with this plant, so that the possibilities of the introduction of mechanical transport into country districts, both at home and abroad, will be greatly increased.

Daimler Premium.

Before the reading of the above paper, the premium kindly awarded by the Daimler Company for the best paper read by a graduate during the session 1918-19 was awarded to Mr. L. Griffiths for his paper on "High-Tension Magnetos." This is the second occasion in succession on which this premium has been won by the Coventry Branch of the Graduate Section.

Admission to the Institution.

The final details of the examination for admission to the Institution have now been settled, and the syllabus has been published. The first examination will be held on February 27th, in London, Birmingham, Coventry, Sheffield, Liverpool, Glasgow, and Bristol. These centres will involve the minimum amount of travelling for any of the candidates.

Council.

Mr. Sydney Straker has found it necessary, owing to pressure of business, to resign from the Council, and the vacancy thus caused has been filled by the co-option of Major Chas. Wheeler, who has done much valuable work on the Council in the past.

The list of the retiring members of the Council at the next Annual General Meeting in March will be circulated to the members, and fresh nominations can be received up to the evening of the 4th February. Members are urged to take this opportunity of exercising their privilege, not only of voting in the ballot which will be held in March, but of putting forward the names of those whom they consider will best forward the interests of the Institution.

Use of Letters M.I.A.E., Etc.

The Council have found it desirable to intimate the conditions under which the letters signifying membership should be used, and have specifically laid it down that they should not be used as shop signs.

Summer Visit, 1920.

It has been provisionally arranged that the visit shall be held from June 21st to June 25th, visiting the Midland Railway Works and the Rolls-Royce works at Derby on the 22nd, travelling on by train to Sheffield, where two days will be spent, and spending the Friday in Manchester. It is admitted that a visit on these lines will offer little relaxation from ordinary business, but the Committee will be very glad to receive criticisms and suggestions with a view to meeting the desires of the greatest possible number of members.

Crompton Medal.

The Crompton Medal for the Session 1918-19 has been awarded to Mr. A. E. Berriman for his paper on "An Analysis of Test Records of some Petrol Engines."

Graduates' Section.

The Coventry graduates held their fifth meeting of the session on the 6th January, when Mr. A. Tilt read a paper on "Ford Methods." The attendance reached the very remarkable figure of 89 members, and a keen discussion followed the paper.

The London graduates, who have perhaps greater leeway to make up, also obtained a very large attendance at the lecture given by the President, Mr. Thos. Clarkson, on Thursday, January 8th, on "Steam Vehicles," when 33 were present. Their second visit was paid on Saturday, January 10th, to the works of Messrs. W. and G. Du Cros Ltd., which always affords much useful information to those who take part.

Trade Items, Notes, &c.

Diesel Engine Users' Association (December Meeting). At the December meeting of the Diesel Engine Users' Association Mr. Chas. Gould, A.M.I.E.E., electrical engineer to the First Garden City Ltd., Letchworth, was elected president for the ensuing year, and Mr. Percy Still, M.I.E.E., M.I.Pet.Tech., chief engineer and manager to the Chelsea Electricity Supply Co. Ltd., was re-elected honorary secretary. Messrs. Geoffrey Porter, A.M.I.C.E., and A. W. A. Chivers were elected members of the general committee, in place of the two members who retire at the end of their term of office. The present members of the standing committee on insurance, which deals with any question arising in connection with the standard policy of insurance against breakdown at Lloyd's, which has been approved and adopted by the Association, were all re-elected for a further term of office. The honorary secretary made his annual statement, referring to the further growth in the membership of the Association and the subjects dealt with and work carried out during the year. Under the present rules of the Association membership is extended to users of semi-Diesel engines. Certain definitions of Diesel and semi-Diesel engines had been discussed and formally adopted by the Association. During the year some cases of breakdowns occurring on Diesel engines had been fully discussed, and, as a result, a considerable amount of useful information had been obtained and circulated among the members. A paper by Mr. Geo. E. Windeler on "A Method of Checking the Alignment of Diesel Engine Shafts" had raised a considerable amount of interest, and correspondence and enquiries on that subject were still being received. The collection of information from various firms of Diesel and semi-Diesel engine manufacturers, insurance companies, etc., on the subject of connecting rod bolts, their periodic renewal or heat treatment, had led to a very interesting discussion, and it was thought that it would probably be advisable to give this important subject further consideration at a meeting in the following year. Mr. Geoffrey Porter had promised to read a paper on "Engine Wear" at the first meeting in 1920. Other work carried out by the Association included the hearing and settlement of a dispute which had arisen between the parties interested in the standard policy of insurance against breakdown at Lloyd's which was adopted by the Association. Successful representation had been made to the Coal Controller to the effect that electricity supply undertakings using oil as fuel should not be subjected to the restrictions imposed by the Household Fuel and Lighting Order, as a result of which the Controller had allowed applications to be made for exemption from the provisions of the Order in the case of

such undertakings. Several electricity undertakings using Diesel engine plant had accordingly been granted total exemption from the Order in the matter of supplies to consumers. The committee of the Association had made their comments and offered their suggestions to the British Engineering Standards Association in connection with a proposed standard specification for Diesel engines for electrical plant. The latest action taken by the Association was in connection with the formation of a Research Association for Liquid Fuels, the object of which was to obtain the co-operation of producers of fuel oils, manufacturers of Diesel and semi-Diesel engines and the users themselves, in endeavouring to promote as far as possible the production from the natural resources of this country of the most suitable liquid fuels for the special requirements of the users. The first members of a provisional committee for a Research Association for Liquid Fuels under the Government scheme of industrial and scientific research had already been appointed. Particulars concerning the Association can be obtained on application to the Honorary Secretary, Mr. Percy Still, M.I.E.E., 19, Cadogan Gardens, London, S.W.3.

Letters to the Editor.

To the Editors of "The Industrial Engineer."

Sirs,—The claim put forward by Dr. Arnold of having discovered a new high-speed steel in which no tungsten is used and the resulting discussion in the press has created widespread interest in metallurgical and engineering circles. As we have been manufacturing tungstenless molybdenum high-speed steels for some considerable time and have given very great attention to the theory and practice of alloy steels generally, perhaps you will permit us to give the public some important facts relating to the matter which have not been brought to light.

We may say at the outset that we fully endorse Dr. Arnold's view that molybdenum in high-speed steel produces far better results than tungsten. We must, however, dispute his claim that his formula is new, and also that vanadium has proved an efficient stabiliser of molybdenum when used with it. As a matter of fact, not long after the introduction of tungsten high-speed steel molybdenum high-speed steel both with and without vanadium was made in the United Kingdom, France, Germany, Luxemburg, Austria and the United States similar to the formula which Dr. Arnold has now made public. The occasional startling results of such molybdenum mixtures, superior to the very best tungsten high-speed steel, induced many firms to plunge into schemes for producing molybdenum steels on an extensive scale, but all had to be abandoned because the resulting product lacked uniformity. Much of it was of excellent quality, but, on the other hand, batches of tools failed entirely when subjected to workshop tests, although they showed the correct analysis. In the cases where vanadium was added it failed to be uniform in bulk manufacture, just the same as the molybdenum steel without vanadium, consequently the makers fell back upon tungsten.

We attribute Dr. Arnold's erroneous faith in vanadium as a stabiliser to molybdenum steel to the circumstance that he experimented merely on small quantities. However, only bulk production can disclose the presence or otherwise of a real stabilising element.

Mr. P. R. Kuehnrich, of Sheffield, who has the reputation of having carried out more tool steel alloying experiments than any living man, made the discovery that cobalt acted as a definite stabiliser to molybdenum, and he patented a formula to this effect.

As the licensees under that patent, we have made and distributed hundreds of tons of the Como brand molybdenum super high-speed steel, and completely proved that cobalt is *de facto* a stabiliser.

"Como" steel is now largely used in many parts of the world, and is thoroughly justifying the warranty advertised in the technical press, guaranteeing it to produce superior results to tungsten high-speed steel.

The molybdenum high-speed steel is more costly to produce than tungsten steel; users, however, are only too willing to pay the higher price as the greater service the material renders makes it intrinsically the cheaper material.—Yours truly,

Darwin and Milner Ltd.,
Sybry Searls and Co. Ltd.,
Spartan Steel Co. Ltd.,

Manufacturers, licensees and distributors of Como (molybdenum super-high-speed steel).

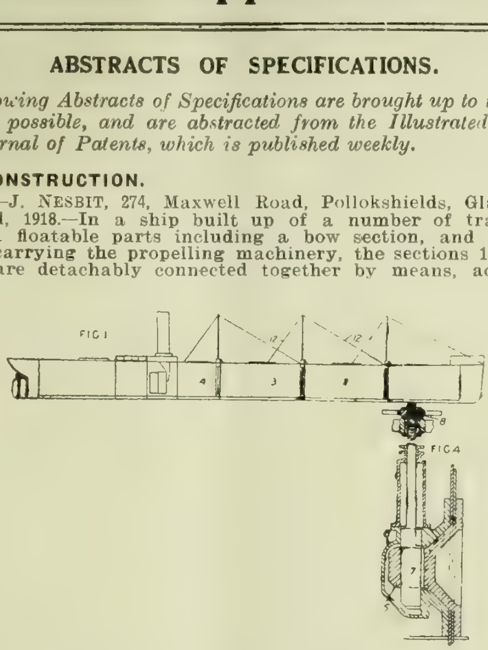
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

SHIP CONSTRUCTION.

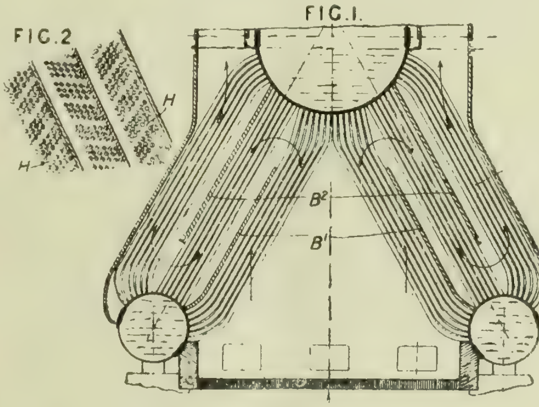
125,243.—J. Nesbit, 274, Maxwell Road, Pollokshields, Glasgow. Nov. 2nd, 1918.—In a ship built up of a number of transverse sectional floatable parts including a bow section, and a stern section carrying the propelling machinery, the sections 1, 2, 3, 4, Fig. 1, are detachably connected together by means, accessible



from the deck, as indicated in Fig. 1, and the decks of all the sections are arranged to form collectively a single deck. The sections are formed with spigot and socket mating-parts 5, 6, Fig. 4, secured by screw-actuated cotters 7, 8. At the deck level, the cotters are driven in horizontally. The small masts and stays 12, Fig. 1, above the deck level constitute an additional means for connecting the sections.

STEAM-GENERATORS.

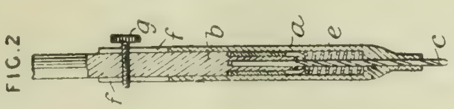
124,256.—C. Evans, 45, Croslands Park, Barrow-in-Furness, Lancashire.—March 16th, 1918.—In a boiler of the kind in which upper and lower drums are connected by banks of inclined



water-tubes on each side of the grate, the tubes in one or more banks are spaced apart so as to form passages H, and baffles B1, B2 are fitted between the banks to direct the gases upwards and downwards. The passages may extend at right-angles or diagonally across the tube banks.

GUIDES FOR DRILLS, TAPS, ETC.

125,804.—R. E. Leak, 52, Penge Road, South Norwood, London.—June 3rd, 1918.—Small drills, taps, and the like tools are supported by a tubular device *a* slidably mounted on the drill, etc.,



c and the holder *b* and held up to the work by a spring *e*. A pin *g* and slots *f* may be provided to ensure the rotation of the guide *a* with the holder *b*, and positive stopping-means may be provided to limit the sliding motion of the guide *a* so that it may act as a depth gauge.

FURNACES.

124,303.—E. C. R. MARKS, 57, Lincoln's Inn Fields, London (General Engineering Co., 75, West Congress Street, Detroit, Michigan, U.S.A.).—April 5th, 1918.—A completely combustible mixture of fuel and air is projected into, and caused to assume a vortex movement within, a shallow flame chamber the walls of

FIG.1

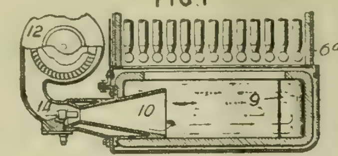
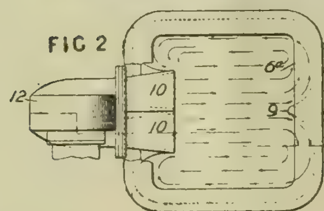


FIG 2

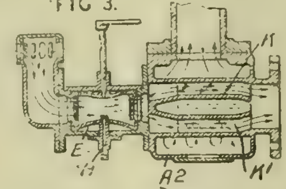


which are inturned at the top to form a baffle flange 6*a*. A vertical deflector 9 is preferably provided. As shown in connection with a water-tube boiler, liquid fuel is delivered by nozzles 14 to two mixing-tubes 10 through which air is delivered by a blower 12.

INTERNAL-COMBUSTION ENGINES.

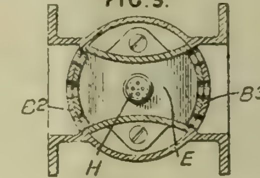
125,843.—C. K. BUTT, L. A. HINDLEY, and H. D. HINDLEY, Bourton, Dorsetshire.—July 12th, 1918.—The choke-tube E rotates about

FIG 3.



a vertical axis, and its ends are closed by curved plates having vertical slots which register more or less with slots in corresponding plates B2, B3, in the casing, and so control the air and mixture. The choke-tube is actuated by governor or by hand, and carries a perforated cap fitting over the nozzle H so as to vary the fuel supply. An extra-air inlet may be provided on the engine side of the carburettor and may be controlled simultaneously

FIG.5.

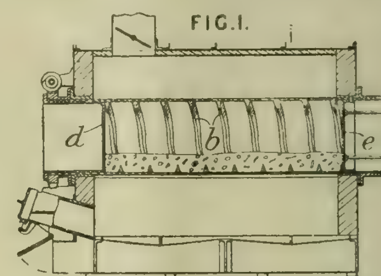


with the choke-tube E. In a modification, the choke-tube rotates about its horizontal axis, the end plates being flat in this case with radial slots. The mixture passes through an exhaust-heated vaporiser, comprising a casing A2 and a central core K having radial helical blades K1.

ROTARY FURNACES.

125,484.—W. O. GARBUTT, and BRITISH CARBONISING CO., Vulcan Works, Quay Street, Gloucester.—Jan. 4th, 1918.—A furnace comprising a chamber mounted to rotate in a stationary combustion chamber and closed permanently at one end *d* and temporarily at the other end *e* is formed with helical ribs *b* of

FIG.1.



small height and constant, relatively small pitch, so that the charge will be moved towards the hotter closed end *d*, where it will be displaced upwardly and caused to fall backward and again be moved forward by the ribs. The furnace is reversed, preferably at a greater speed, for discharging, a suitable arrangement of toothed gearing for this purpose being described. The furnace is specially adapted for carrying out the carburising and case-hardening process described in Specification 114,446.

INDEX TO ADVERTISERS.

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— THE —

Industrial Engineer.

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A PRACTICAL MAGAZINE FOR ENGINEERS AND POWER USERS.

Published twice monthly, on the 8th and 22nd days, respectively.

All communications intended for insertion in the Industrial Engineer, *or relating to Editorial matters, should be sent addressed to "The Editors," at our Office,* 121, *DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

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CONTENTS.

EDITORIAL.

COAL ECONOMY.

When one thinks of coal consumption it is in big figures, and the economists have to make their computations big if they are to appeal to users. It is therefore a common thing to read of a saving of millions of tons of coal if certain definite plans are put into general practice. In considering coal consumption the use of this fuel for domestic purposes is overlooked. That we do not get the best out of the coal consumed in the domestic grates is a truism that is apparent. Moreover, the damage occasioned by smoke in such large centres of industry as Manchester, Sheffield, or Leeds, is not in the main due to the outpourings of the works' or factory chimneys, but in the main to the thousands of house fires that are economically wasteful and inefficient.

We have lately perused an extremely practical little book with the above title, written by Mr. W. H. Casmey, who has had practical experience of the layout and working of boilers extending over thirty years. The writer sees no reason why 50 million tons of coal out of our yearly consumption of 190 millions a year should not be saved.

Mr. Casmey does not theorise. He has the courage of his convictions, and long practice, and proves that it is the lack of uniformity between the fire grates and the outlets for the products of combustion that is the principal cause of coal wastage.

A table shown of the details of a standard Lancashire boiler is given. In this we find that the nine-feet diameter boiler can evaporate 34 per cent more water per square foot of grate than a boiler seven feet in diameter, the reason being that the larger boiler has $2\frac{3}{4}$ square feet of grate for the same area of outlet for its gases as four square feet of grate has in the smaller boiler. In practice this means that one nine-feet diameter boiler will evaporate as much water, and do so more economically from its 45 square feet of grate than two seven-feet diameter boilers can evaporate in the same unit of time, although in the latter case the grates are 66 square feet. "The conservative idea that the duty of a boiler is proportional to the size of its furnace is responsible to a great extent for our present wasteful position."

Many of our readers will hardly credit the fact that some 40 million tons of coal per year are consumed in domestic grates. This amount it is claimed may be reduced fully by 26 per cent. On this matter Mr. Casmey is very clear, and has evidently devoted considerable attention to the methods employed. Gases liberated from a fresh charge of fuel will not ignite at a lower temperature than 900 deg. Fah. It is therefore very evident that to allow a fire to become reduced to a few red cinders at the bottom of the grate and then to throw on a shovelful of coal will not secure the best or most economical results. It stands to reason that the temperature of the grate is cooled below the gas-ignition point, and in consequence a steady stream of smoke passes up the chimney. During the period that elapses until the temperature of the fire surface reaches 900 deg. 25 per cent of the total weight of coal has escaped.

There is a good deal of very practical matter in this little book, which is published by Charles Griffin and Co. Ltd., Exeter Street, Strand, London, W.C. 2. It has a foreword by Mr. T. Roland Wollaston.

ELECTRICAL DEVELOPMENT IN AUSTRALIA.

Government Aid for Electrical Undertakings.

Following the electrification of the suburban railways of Melbourne, the capital city of Victoria, part of which work is now sucessfully in operation, the State Government has taken in hand the provision of electricity on a large scale to meet the steadily increasing demand for light and power for use upon the railways, tramways, in workshops and factories, and public service generally, using as the source of power the lignite, or brown coal of Victoria. The proposed installation will be one of the largest, if not the largest, undertaking of the kind hitherto attempted, employing coal instead of water power.

The Supply of Coal.

As regards black coal of any kind, the State of Victoria, so far as is at present known, is not very well endowed; but to compensate for this, Victoria has immense resources of brown coal, not surpassed for quality and easy accessibility by similar deposits in any part of the world. Within the metropolitan area, or, in other words, within a 10-mile radius from the centre of the city of Melbourne, there are thousands of acres of land underlying which is coal from 70 ft. to 150 ft. in thickness, at a depth of from 110 to 160 yards from the surface. Outside the circle, and not exceeding at the farthest point a distance of 40 miles from the city, there is 1,600 square miles of territory, within which coal equally plentiful is stored. In the province of Gippsland, about 90 miles from Melbourne, there are extensive areas in which brown coal, having a depth or thickness of 750 ft., has been proved by bores put down. Here, in some places, the coal forms a huge outcrop, and can be got by quarrying at a cost estimated not to exceed 2s. 6d. per ton. It is at Morwell, in Gippsland, that the Government of Victoria, guided by the advice of three specially appointed Electricity Commissioners, has decided to erect the works for the generation of electricity. The cost of this installation will not be less than £3,000,000 sterling, probably more.

The Cost of the Undertaking.

In the course of a debate now proceeding in the Legislative Assembly of Victoria, several speakers seemed to think that the ultimate expense has been much under-estimated, and they point out that the electrification of the State-owned suburban railways, the cost of which was originally fixed at three millions, has expanded to between seven and eight million pounds. This is a common experience with all Government enterprises, when the work is carried out, not under contract, but by day labour, the popular method under State socialism which tends to increase in these Colonies.

The Details Briefly Explained.

Regarded simply as an engineering work, the plan of the Electricity Commissioners can be briefly explained.

It is to erect a power station, having a present capacity of 50,000 kw. and an ultimate capacity of 100,000 kw. at 20,000 volts, as near as practicable to the open cut or quarry where the brown coal is wrought, the cost of generation being reckoned at 0·267d. per unit.

There will be the usual accessories of a modern power house, viz., water-tube boilers, automatic stokers, steam turbines, condensers, etc. The brown coal when newly gotten contains from 45 to 50 per cent of moisture, and the direct firing of this damp fuel is not regarded favourably by many highly qualified and experienced engineers. The nature of this coal may be specifically stated thus: Carbon, 66·5 per cent; hydrogen, 4·4 per cent; oxygen, 25·5 per cent; nitrogen, 0·8 per cent; sulphur, 0·3 per cent; ash, 2·5 per cent. It yields in distillation from 10,000 to 12,000 cubic feet of gas per ton, inferior of course to gas obtained from bituminous coal, nevertheless fairly good. Also, the by-products commonly furnished by black coal, leaving a species of carbon residue in volume equal to 50 or 60 per cent, very pure, standing midway between wood, charcoal, and coke. It would have been more in accordance with sound, economic practice to carbonise this coal, rescuing the volatile by-products and using the so-called waste gases as fuel for the generation of electricity.

But, although the Electricity Commissioners are aware of these features, they have elected, in the outset, to disregard them, a decision which does not commend itself to well-trained observers. The capital expenditure on the power-house at Morwell is estimated at £1,262,500. This is to provide for five generating sets, each of 15,000 kw. maximum capacity, or a total installed capacity of 75,000 kw.

Transmission.

The current is to be transmitted to Melbourne by copper cables resting on steel supports or towers. The details of this part of the scheme are: Route length, 82 miles; voltage, 110,000 volts; sectional area and material of conductors, 0·166 square inch copper; number of circuits, 2; number of towers per mile, 8 (average); c.i.f. price of copper, £120 per ton; c.i.f. price of steel, £26 per ton; total cost per mile of transmission line, £3,160. There will be a terminal sub-station wherin to house the step-down transformers for the reduction of the transmission voltage and the switch gear for the control of the same, estimated to cost £105,000. Likewise, 30,000 kw. of synchronous condensers and plant connected therewith to cost £57,750.

A Chance for British Makers.

As only a very small portion of the material and machinery needed for this installation can be produced in Australia, the orders must necessarily be given abroad, and for this class of work America is competing very strongly.

Under the Commonwealth Customs tariff at present in force, a preferential rate of duty, amounting variously from 5 to 10 per cent *ad valorem*, is accorded to goods of British manufacture. This preference may be increased when the new Parliament assembles after the elections now in progress. Therefore, a considerable amount of business is likely to accrue to engineers and other manufacturers in the United Kingdom. Later, when the installation is completed and electric power is available from it, there will be a greatly increased demand for electric motors for use in factories and workshops, and generally for electrical supplies of all sorts.

MAKING GOOD.

One of the humours of the old time shop was the advice to use a putting-on tool, when by accident or lack of skill too much had been removed from the job. Since the advent of modern welding processes the joke has lost most of its point; it is now possible in more than one way to use a putting-on tool without scrapping the piece.

Making good is a phrase with fairly universal applications, it applies to reconditioning and total overhaul as well as to small adjustments necessitated by wear or abuse. It implies a restoration of good working conditions, and a new term of service without nursing or any need to lessen the load, or because of imperfection to be relegated to an inferior classification. Shortly, it means not merely a new start but a start at the same level.

Curiously enough, engineers are severe critics of mechanism in other hands which is allowed to fall into decrepitude for want of attention, while at the same time the production plant under their own control gets scant repair, until something happens which necessitates placing a machine out of commission for a lengthy spell to overhaul completely.

Like many more experts, the mechanical man is apt to bank on an original factor of safety, carry big overloads, and because he is competent to repair the damage he takes additional risk. No engineer takes his own physic in this particular unless, on the contrary, he is blessed or cursed with the faculty of excessive caution.

It is open to question whether, from the point of view of long service, insight or ignorance of mechanism has the advantage. It is, of course, possible to recondition even the worst case of mechanical casualty or infirmity, or to rectify and restore the most decrepid article in the shape of plant, but whether it pays is quite another matter. Faced one time with a reputed engineering bargain at one-third of the cost of new, the responsible man reasoned out the case and found the offer far less tempting on reflection. First, although the plant would give him the result he wanted, he had to allow for wear and tear, he woud have to recondition—this at an unknown expense; then again, suppose at half the price paid he had something reasonable, it was out-of-date and at best second-hand. The decision was rightly adverse, the total gain in initial price, added to subsequent expense, merely gave obsolete running plant. The shrewdest may be loath to pay the price of replacement, and may carry on with present equipment; but when extension is in question or replacement necessary, then new plant has numerous advantages which turn the scale.

Scrapping has its uses, and should be more diligently practised on the grounds of sheer economy; there is far too much obsolescent machinery in existence, and the retention of this is always dubious wisdom. Making good, by the installation of new plant, is preferable to making good by overhaul and repair in a large majority of instances. One firm, unable to compete by the handicap of obsolete plant, had the courage to scrap the lot, suspend business for months, design the most up-to-date in existence for its purpose, and are now prosperous instead of just paying their way. They stopped in time, before liquidation became necessary. It needs courage and no small heroism to take so serious a course, but it paid. More than one firm have sectionalised their plant, scrapped or sold a third, and replaced with the latest equipment, thus impeding their output for a term, and then from the profits of the renewed third replaced a second section and later the first, to their ultimate advantage. Present labour costs and shorter working hours compel readjustment and improvement of process.

Labour's alleged lack of effort has met the retort that the lack was one of acumen and intelligence higher up, and the charge is partly true.

Post-war prices are providing some surprises, profiteering apart—keen competitive bids show remarkable differences, the well equipped firm when quoting shows up in a most extraordinary way beside the somnolent. Both during the war, and subsequent to the armistice, certain firms have made good in a remarkable manner. To them, a period of stress has led by the pressure of circumstance, to a period of rejuvenescence—reconstruction in their case has been real, not a shibboleth without meaning. There are other cases less pleasant.

Turning aside to the human aspect of making good, in how many cases has this also been dependent upon some catastrophe, few men are much good until at length by the road of mistake and discipline they arrive at competence. Sometimes the best asset a man can have is that he once failed lamentably and only succeeded when with his back to the wall he fought for himself, stripped by circumstances of any external support. It has been known to take large misfortune and severe calamity to reveal human value, the man with grit rarely errs in the same way twice.

The present is a period of making good, cutting losses, revealing determination; evolution in the ordinary way was gradual and the pressure was at best incremental toward change. Large reassessment means great opportunities at both extremes of the scale, and out of ill comes always some measure of good. It is folly repining that the industrial world has altered, that its complexion has changed; greater folly still to sigh for the good old times of 1914. There were many signs and portents even then which must have resulted in severe alteration sooner or later. There was distemper and little satisfaction; it was not that we were not opulent, but many things were inherently wrong. Nationally the worst crisis is passed, and to-morrow can be faced without trepidation if we are determined to make good.

RECTANGULAR AREAS. By A. W. M. Elliott. London: Scott, Greenwood and Son, 8, Broadway, Ludgate, E.C. 7s. 6d. net.

We have here a book that on the face of it has apparently been produced without a great deal of effort. Only those who have attempted to prepare similar works will appreciate the tremendous amount of tedious, careful labour required to present to the reader or user such a multitude of compilations. There can be no doubt as to the practical usefulness of the book, and all those who have use for superficial areas in their business will find it of considerable service.

THE LOCATION OF HARDENING-SHOP FAULTS.

By Fred. C. H. Lantsberry, M.Sc., F.I.C.

A knowledge of the equilibrium diagram of the iron-carbon alloys should be acquired by every responsible hardener, because to him such knowledge is as essential as is a knowledge of the properties of materials to the designer. The equilibrium diagram is simply a graph which represents the relations existing between composition and the properties of a series of steels and cast irons, and is based on the results obtained from heating and cooling curves extended by the microscopic examination of quenched and annealed samples. If a series of steels

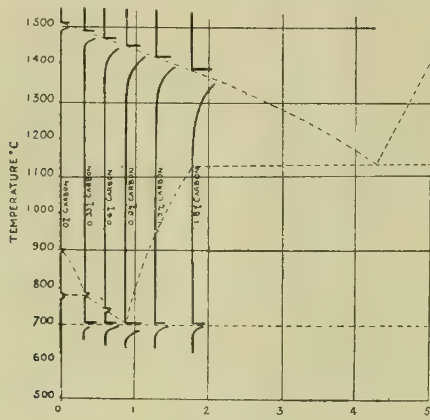


Fig. 2.

containing 0, 0·2, 0·33, 0·6, 0·9, 1·3, and 1·8 per cent carbon be melted and their cooling curves taken down to 400 deg. Cen., a series of inverse rate curves as shown in Fig. 2 will be obtained. It is not claimed that these are actual curves; they have been idealised for instructional purposes. The upper arrest point in each case corresponds to the temperature at which the steel, of the carbon content indicated along the curve, begins to solidify. Pure iron, for example, solidifies at 1,505 deg. Cen., but as the carbon content increases, so the temperature of solidification decreases, and a steel containing 1·8 per cent of carbon does not reach the temperature at which solidification begins until somewhere in the region of 1,380 deg. Cen. Not only does the addition of carbon decrease the melting point, but at the same time it introduces another effect which is of great importance in considering the phenomena of overheating and burning in steel. This effect consists in introducing a range of temperature over which fusion and solidification takes place. Pure iron begins and completes it solidification at a constant temperature, viz., 1,505 deg. Cen., but the 1·8 per cent carbon steel mentioned previously, although commencing to solidify at 1,380 deg. Cen., does not complete its solidification until the temperature has fallen to 1,135 deg. Cen.

In a general way hardeners are not concerned with alloys containing over 1·8 per cent carbon, because this limit really represents the dividing line between steel and cast iron. That this dividing composition is not purely an arbitrary one, but has some considerable foundation in fact, will be seen from the sequel.

In order to round off our knowledge, it will suffice to say here that the addition of further carbon continues to decrease the temperature at which solidification begins, and also to decrease the temperature range of solidification until a content of 4·3 per cent is attained. This composition constitutes the true eutectic of the iron carbon alloys, and its solidification proceeds at the constant temperature of 1,135 deg. Cen. The eutectic really consists of mixture of cementite and austenite, and has been called "Lederburite," after the celebrated German metallurgist Ledebur. As the carbon is increased above 4·3 per cent, a gradual increase takes place in the temperature at which solidification begins.

Examination of the cooling curve of pure iron reveals two arrest, or critical, points considerably below the temperature of solidification, one at 900 deg. Cen. and the other at 760 deg. Cen. The 0·2 per cent carbon steel, however, shows three arrest points; the upper one is lowered, the second one is unaffected, and a third point is introduced at 700 deg. Cen. From this we learn that while the two upper points are attributable to changes occurring in the iron itself, the lower point is due to some action introduced by the presence of carbon. With 0·33 per cent carbon the upper point is lowered until it coincides with the second critical point, and the lower one is increased in magnitude. Further increase in the carbon content causes lowering of the combined point, until with 0·9 per cent carbon the three points are combined into one large arrest occurring at 700 deg. Cen. Above 0·9 per cent carbon a new upper point is introduced, and this increases in both magnitude and temperature until a carbon content of 1·8 per cent is attained, when the critical point has risen to 1,135deg. Cen., at which it remains constant with further increase of carbon.

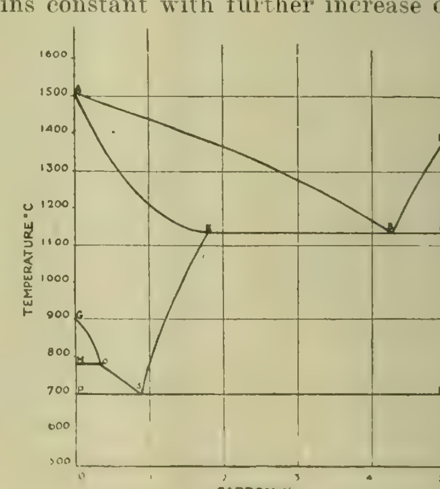


Fig. 3.

Fig. 2 shows an idealised series of inverse rate curves for the whole gamut of steels, but it should be pointed out here that while the ordinary temperature-recording apparatus of the hardening shop will detect the lower critical points, the upper points require the more sensitive laboratory apparatus for their adequate detection.

Quite early in the history of the metallurgy of steel the critical points found in the solid state were denoted by the letter A, and they were subsequently

distinguished from each other by calling the lower point A1, the middle one A2, and the upper one A3. The fact that owing to lag the arrest points occur at higher temperatures on heating than on cooling has already been pointed out. This is true of the points A1 and A3, but recent research has shown that A2 occurs at the same temperature on both heating and cooling. It may be taken that the heating curves of the series of steels under discussion would be of similar shape to the cooling curves illustrated, but the points A1 and A3 would occur at some 20 deg. to 40 deg. Cen. higher temperatures, depending upon the exact conditions of carrying out the experiments. The arrests on heating are distinguished by affixing the initial letter of the French word "chauffage," meaning "heating"; and the arrests on cooling by adding the small letter "r" from the French work "refroidissement," meaning "cooling." Thus, the arrest points on heating are denoted by the Ac1, Ac2, and Ac3; and those on cooling by Ar1, Ar2, and Ar3. Another term which has been applied to the lower critical point, more particularly in high-carbon steels, is "recalescence," which refers to the visible increase of temperature appearing when a piece of red-hot carbon steel is allowed to cool in the dark. Recalescence is really the result of the phenomenon of under-cooling, *i.e.*, cooling to below the critical temperature under such conditions that the transformation does not take place. Ultimately, however, the change does occur, and the sudden liberation of a large amount of heat raises the temperature of the whole mass up to the critical point, with a consequent brightening in colour of the object. The term "decalescence" has been used to describe the change taking place on cooling, but the term is not a good one, because if it means anything at all, a decrease in temperature is indicated, and this is impossible, because the reverse phenomenon of superheating has not been observed in steels, and on heating, the transformation takes place as soon as the Ac temperature is reached.

Returning to consideration of Fig. 2, it will be seen that a series of dotted lines can be drawn through the various critical points, and these dotted lines form the basis of the equilibrium diagram, which has been completed and drawn out in full in Fig. 3. The position of the line A—E cannot be determined accurately from examination of the cooling curves, but its position has been fixed definitely by heating steels of varying carbon contents to gradually-increasing temperatures, fixing their structures by very rapid quenching and, by subsequent microscopic examination, determining those specimens in which fusion had just commenced. The line A—E is drawn through the temperatures corresponding to those specimens. Now A—B represents the temperatures at which the steels begin to solidify, while A—E shows the temperatures at which the solidification is complete; G—O—S represents the temperatures at which the allotropic changes take place in iron, S—E points out the temperatures at which excess cementite goes into solution, and the horizontal line P—S—K, passing through the pearlite change-point S, indicates the temperatures at which the carbide in the steels commences to go into solution. In fact, the whole diagram is simply a kind of map, or guide to the proper treatment of steels; the lines divide the diagram into various fields and when, by virtue of its carbon content and the temperature to which it is heated, a steel crosses one of the lines into a certain field, the condition in which it exists is prescribed, and the hardener's work consists in getting the steel into one or other of these prescribed conditions.

The practical hardener is apt to be afraid of this diagram and to describe it as too scientific, and yet his work consists wholly in putting into operation scientific laws, *e.g.*, when a piece of steel is carburised, the laws of chemical combination are invoked, and when it is subsequently reheated and quenched, the laws of solution are put into operation. Transgression of these laws means failure, so that the responsible hardener should strive to attain familiarity with the equilibrium diagram, because such knowledge will enable him to determine at a glance the correct treatment for a steel of known composition, and he will then be in a position to cut out the laborious and expensive methods of trial and error.

HOW TO SECURE INDUSTRIAL PEACE.

By Sir Charles W. Macara, Bart.

I have been asked to give my views upon the Court of Industry proposal which is now being considered by the public of the United States; and I have great pleasure in accepting the invitation, since the question—that of the best means of securing industrial harmony—is one which I have studied for a great number of years, not only in its national but in its international aspects. There never was a time in the history of the world when the subject of industrial peace was so widely discussed as at the present time, nor a time when it was so necessary to find a way of securing it.

My experience, I think, gives me some claim to a special knowledge of the methods which are most likely to achieve the end in view. For 30 years I have had the privilege to play a leading part in directing the great cotton industry of England, and, as President of the Federation of Master Cotton Spinners' Associations—perhaps the most powerful and compact federation of employers in the world—I had unique opportunities of watching at work the forces which produce industrial unrest, and of studying the best ways of dealing with that unrest. I may add that in this Federation there is a number of large firms which are manufacturers as well as spinners. I knew the cotton trade before the 20 weeks' strike in 1892-3, and took a leading part in that struggle, as well as in the formulation of the Brooklands Agreement which ended it—a veritable landmark in its history—and have been intimately associated with its direction ever since. Before that memorable struggle, the cotton trade of Lancashire was the cockpit of industrial strife. Had that state of things continued, I have no hesitation in saying that half the Lancashire cotton industry would have been lost. Owing to industrial harmony, however, a great development of the industry has taken place. After the struggle was terminated by the Brooklands Agreement, during a period of 21 years (throughout which I presided at every conference dealing with the industry as a whole, by the unanimous vote of employers and employed) there was only one general strike. Such was the effect of the Brooklands Agree-

ment; coupled with wise management of the industry. That Agreement was a masterly piece of statesmanship in industry: it contained the seed of many of the subsequent schemes for preserving industrial peace, and it contained also very important lessons for us to-day, some of which may very aptly be applied to the Court of Industry proposal now before the American people.

I have always laid stress on the interdependence of industries, a fact which has become more and more apparent to me through the connections I have had with both national and international industrial movements, such as that of the International Cotton Federation, of which I was founder and for many years President, and the International Institute of Agriculture, in framing which I had the pleasure of assisting that great American, David Lubin, who did so much to bring the agricultural interests of the world into line. Industry is one and indivisible; any disturbance of one part of it reacts to the disadvantage of all the other parts. For instance, in the only general stoppage in the cotton industry which took place during the 21 years' period of my presidency of the Master Spinners' Federation, the action of the section which brought about the stoppage led to the paralysis of the whole industry, and all the subsidiary, dependent and commercial interests. Similarly, disputes in one industry react upon other industries, and therefore in all our legislation affecting industry, the great thing to keep in mind is the interdependence of all its parts. No good can come of any legislative schemes which ignore this cardinal fact.

I have always had a strong preference for fact as against theory. I like to point to what has been done as showing what may be done. In the case of the Industrial Courts proposal now before the people of the United States it is specially apposite to do so. For that proposal has a great deal in common with the Industrial Council, formed by the British Government through my advocacy in 1911; that Council was, I venture to say, as nearly ideal in constitution as any human instrument can be. It was composed of representatives of both Capital and Labour from every great industry, whose Chairman was Sir George (now Lord) Askwith, chosen in order that the position he filled should be free from any associations which might give rise to bias. Everybody else on the Council was an expert in some industry or other. That Industrial Council achieved in its short life a very remarkable success; in fact, its very success excited the jealousy of the professional politicians in England, who felt that it left them with nothing but a back seat, since it placed the control of industry in the hands of the practical men associated directly with it. Consequently it was allowed to fall into disuse, the politicians pulling the strings against its employment. Had it been utilised at the outbreak and during the war, much dislocation and loss would have been saved to British industry. In the cotton trade alone, millions of money would have been saved. In fact, during the war, the only satisfactory period in the cotton trade was that when it was under the guidance of the Cotton Control Board; and the Cotton Control Board was framed upon the principles which were embodied in the Industrial Council.

Though the Industrial Council itself was thus allowed to remain inoperative, the ideas upon which it was founded are more widespread and more vital to-day than ever they were. On those ideas President Wilson recently based the suggestion leading to the settlement of the great American coal strike. On those ideas Britain might have founded her industrial peace policy. In France, Belgium, Italy and Switzerland, legislation has recently been passed embodying those ideas as the best adapted to allaying industrial trouble. And the principles which formed the basis of the Industrial Council are plainly evident in the proposal for Courts of Industry in the United States now under review. What is the explanation of this widespread diffusion of the Industrial Council idea? Simply that the idea is based upon logic, insight and a thorough knowledge of the requirements of industry.

I would, in the rest of this article, take the opportunity of pointing to what I consider the cardinal features of any measure—like your Court of Industry proposal—designed to meet the industrial situation. The first and foremost is that industry should manage its own affairs. This is a lesson taught by the success of the Brooklands Agreement and of the Industrial Council; taught no less by the failure of schemes which have given room for the interference of lawyers and politicians. Apart from the position of chairman, only practical men associated with industry should be allowed to sit upon the Court of Industry. I am glad to note how widely this fact is recognised in the United States.

It is equally important that each industry should be treated as a whole. One cannot lay too much stress on this. When disputes arise in an industry, there must be ready means of discussing and settling them by experts, both on the side of Capital and Labour in the industry itself; but, if no settlement can be arrivd at in this way, then there must be a central court or council, composed of representatives of both employers and workers who have practical experience of the working of the staple industries, to which the disputes can be referred. A Court composed mostly of Government officials such as has been recently appointed by the British Government could only have been created out of officialdom. No practical men would ever suggest such a constitution for a Court whose duty is the settlement of labour disputes. This newly-formed body can in no sense be considered a lineal descendant of the Industrial Council of 1911. That Council was composed of men holding the most prominent positions in the organisations controlling the staple industries of the country.

The idea of compulsory arbitration is impracticable, and must not be imported into the American Industrial Court scheme. In matters of industrial disputes, the only compulsion is public opinion. The great desideratum, I have always maintained, is to get an impartial verdict from an experienced, authoritative and representative body, and then the parties will hesitate to take any step to set that verdict aside. Whoever did so would put themselves in the wrong in the eyes of public opinion, which, in all such matters, is the supreme arbiter. Of course, this assumes that all the verdicts of the Industrial Court would be given the widest possible

publicity; but that is so self-evident a necessity that I think it need not be stressed.

These things, then, I suggest as the main principles in any such proposal as that of the Court of Industry. (1) Arbitration by practical men associated with industry. (2) Treating each industry as a whole. (3) Getting a sufficiently weighty verdict to ensure public support against any party which might prove recalcitrant. Here we have a solvent for industrial unrest which has been tried with a measure of success that encourages the largest hopes for the future, and I recommend the embodiment of these principles in the American proposal in a stronger form than has yet been secured. In conclusion, I would add that the Court of Industry need not limit itself to the consideration of actual disputes. It should endeavour to find means of preventing their occurrence. Much along this line was done by the Industrial Council, and the good results are still felt in England; and there is no limit to this field of endeavour if only the right men and the right principles find representation in the central body which is elected to lay down rules for the conduct of industry.

A NEW THEORY OF PLATE SPRINGS.

By DAVID LANDAU AND PERCY H. PARR.

(*Continued from page 143.*)

WE must now consider the *special case where* $b = d$, for which the preceding analysis fails to give the result. For this particular case we have:

$$\frac{EI_0}{W}\frac{d^2y}{dx^2} = (a+b)(c+d)^3 \frac{(l-x)}{(l+b-x)^4} \quad \ldots\ldots\ldots(48)$$

$$\frac{EI_0}{W}\frac{dy}{dx} = (a+b)(c+d)^3 \left\{ \frac{-b}{3(l+b-x)^3} + \frac{1}{2(l+b-x)^2} \right\} + C_1 \quad \ldots\ldots\ldots(49)$$

$$\frac{EI_0}{W} y = (a+b)(c+d)^3 \left\{ \frac{-b}{6(l+b-x)^2} + \frac{1}{2(l+b-x)} \right\} + C_1 x + C_2 \quad \ldots\ldots\ldots(50)$$

This concludes our study of the No. 7 point, for which it does not appear to be necessary to give a numerical example, and we at once pass on to the consideration of the remaining types of double tapered leaf points.

No. 8 or Round-tapered Leaf Point.

The remarks made with reference to the No. 3 point apply also to this type of point—the effect of the rounding is absolutely negligible: the tapering the rounding is *nil*, so that the reactions, etc., for in the thickness is very important, but the effect of this type of point may for all practical purposes be calculated by means of the equations for point No. 6.

No. 9 or Circular-tapered Leaf Point.

The remarks made above regarding the No. 8 point apply, without modification, to this type of point. The rounding of the ends of the leaves with the No. 8 and No. 9 points may, perhaps, improve the appearance of the springs, but it has no effect on the strengths, flexibilities, or endurances.

No. 10 or Parabolic-tapered Leaf Point.

This "double-tapered" type of leaf point is of more importance than the others, especially when combined with a "stress-equalising slot," and is the subject of several patents in connection with plate springs.* The taper in the thickness has much more effect than has that in the width, but still, the effect of the taper in the width cannot be ignored. This point is shown on a larger scale in Fig. 26, where also are indicated the symbols which will be used in the analysis. As with the point No. 7, there are several possible cases according as to whether a is less than, equal to, or greater than c: these variations, however, do not cause any trouble in application, since it is merely a matter of selecting from the equations given earlier in the paper those applying to the portion of the leaves before the double taper commences.

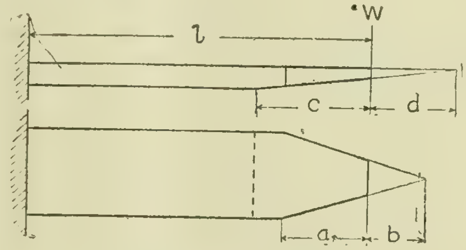


PLATE SPRINGS.—FIG. 26.

In order to determine the deflections of the leaves with the No. 10 point, we see, on referring to Fig. 26, that from $x = l - a$, where the double taper commences:

$$I = I_0 \left(\frac{l+b-x}{a+b}\right)^{\frac{1}{2}} \left(\frac{l+d-x}{c+d}\right)^3$$

so that:

$$\frac{EI_0}{W}\frac{d^2y}{dx^2} = \left(\frac{a+b}{l+b-x}\right)^{\frac{1}{2}} \left(\frac{c+d}{l+d-x}\right)^3 \left(l-x\right) = (c+d)^3$$

$$\left(\frac{a+b}{l+b-x}\right)^{\frac{1}{2}} \left(\frac{-d}{(l+d-x)^3} + \frac{1}{(l+d-x)^2}\right) \quad \ldots(51)$$

This expression is not an easy one to integrate, but so long as $b < d$, which is always the case in the practical spring, it may be integrated by means of the substitution:

$$l + b - x = (l + d - x)\sin^2\theta,$$

by the use of which we have:

$$-x = (d-b)\tan^2\theta - (l+b)$$

$$dx = -2(d-b)\tan\theta\sec^2\theta\, d\theta$$

$$l + b - x = (d-b)\tan^2\theta$$

$$l + d - x = (d-b)\sec^2\theta$$

$$\sin^2\theta = \frac{l+b-x}{l+d-x}$$

$$\cos^2\theta = \frac{d-b}{l+d-x}$$

* The reader may find it to his interest to peruse the patents which resulted from the research work contained in these papers. We direct attention to the following American patents, all issued in the name of David Landau:

Name of Patent	Date of Issue	Patent No.
Laminated Spring	Sept. 19, 1916	1,199,038
Laminated Spring	Sept. 19, 1916	1,199,013
Laminated Spring	Oct. 2, 1917	1,241,743
Spring	Oct. 2, 1917	1,241,744

Similar patents, in whole or in part, have been issued in Canada, France, Spain, Italy and England. Patents are also pending in Belgium, Russia, Canada and England. Applications were instituted in Germany prior to the war—at present these are withheld.

$$\tan^2\theta = \frac{l+b-x}{d-b}$$

$$\sin\theta\cos\theta = \frac{(l+b-x)^{\frac{1}{2}}(d-b)^{\frac{1}{2}}}{l+d-x}$$

$$\frac{dx}{(l+b-x)^{\frac{1}{2}}(l+d-x)^3} = \frac{-2\cos^4\theta\, d\theta}{(d-b)^{\frac{5}{2}}}$$

$$\frac{dx}{(l+b-x)^{\frac{1}{2}}(l+d-x)^2} = \frac{-2\cos^2\theta\, d\theta}{(d-b)^{\frac{3}{2}}}$$

Using these relations, it will be found that:

$$\frac{\mathrm{EI}_0}{\mathrm{W}}\frac{dy}{dx} = \frac{(a+b)^{\frac{1}{2}}(c+d)^3}{4(d-b)^{\frac{5}{2}}}\Big\{(4b-d)(\sin\theta\cos\theta+\theta) + 2d\sin\theta\cos^3\theta\Big\} + \mathrm{C}_1 \quad \ldots\ldots\ldots (52)$$

where C_1 must be determined in the manner explained for the leaf point No. 7, by comparing the values of dy/dx from the equation corresponding to the first portion of the leaf with that given by the above equation.

A second application of the same transformation will enable equation (52) to be integrated in order to determine the value of y, and the result, after absorbing the constant part of x into C_2 will be found to be:

$$\frac{\mathrm{EI}_0}{\mathrm{W}} = -y\frac{(a+b)^{\frac{1}{2}}(c+d)^3}{4(d-b)^{\frac{3}{2}}}\Big\{(4b-d)(\theta\tan^2\theta + \tan\theta-\theta) + 2d(\theta-\sin\theta\times\cos\theta)\Big\} - \mathrm{C}_1(d-b)\tan^2\theta + \mathrm{C}_2 \quad \ldots\ldots\ldots (53)$$

where, of course, C_2 is to be determined in a similar manner as before.

When using equations (52) and (53), it must be noticed that θ, when standing alone or appearing as a factor, must be expressed in circular measure or radians, since it has made its appearance on account of integrations of circular functions. The value is easily obtained by extracting the square root of $\sin^2\theta$ in order to obtain $\sin\theta$; referring to the ordinary tables of natural sines for the value of θ in degrees, minutes and seconds, and then referring to the table of Circular Measure, given in most books of mathematical tables, one may find the circular measure of the angle.

At the end of the leaf, where $x=l$, the expressions given for the values of the circular trigonometrical functions of θ reduce to:

$$\sin^2\theta = b/d$$
$$\cos^2\theta = (d-b)/d$$
$$\tan^2\theta = b/(d-b)$$
$$\sin\theta\cos\theta = b^{\frac{1}{2}}(d-b)^{\frac{1}{2}}/d$$

and when we have $b=0$, then at the end of the leaf, with $x=l$, the $\theta=0$ (zero) and equation (53) reduces to the sample form:

$$\frac{\mathrm{EI}_0}{\mathrm{W}}y = \mathrm{C}_2 \quad \ldots\ldots\ldots (53a)$$

These expressions are admittedly very complex; in most cases, however, the somewhat simpler equations for the No. 6 point will be found to be sufficient to give the required degrees of accuracy, although there are occasions when it is necessary to apply the equations of the present section of this paper. There is no real difficulty in the application, but there is a *very considerable amount* of arithmetical labour; it seems impossible to avoid this, when dealing with these types of "double taper" points, and so one must be satisfied to perform the laborious numerical work in order to obtain the very important results which may be deduced from their applications.

This type of point (No. 10) being of practical as well as theoretical impoιtance, a numerical example will be given, although on account of the very considerable amount of labour involved in working out completely an actual spring, the work here will be confined to two plates only. The two-plate spring for which the calculations will be given here

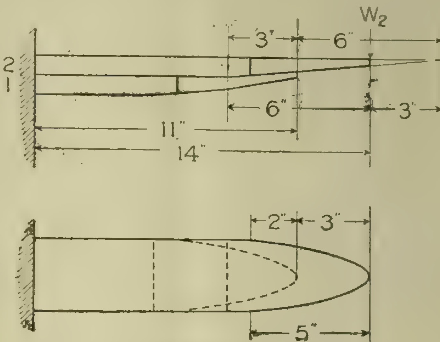


PLATE SPRINGS.—FIG. 27.

is that shown in Fig 27; on this figure most of the data necessary for the present purpose will be found. We now proceed to the necessary calculations.

First, for Plate No. 1.

Referring to Fig. 27, it will be seen that the double taper commences at $x=6$, at which point, on the left-hand side, the equations for point No. 6 hold. It will also be seen that $l_1=11$, $a=5$, $b=0$, $c=6$ and $d=3$.

Now using the equations for the No. 6 type of point for the point $x=6$ we find that:

equation (43) gives $C_1 = -25$,
equation (44) gives $C_2 = 1965$;

then using these values:

equation (41) gives $\dfrac{\mathrm{EI}_0}{\mathrm{W}}\dfrac{dy}{dx} = 49$

equation (42) gives $\dfrac{\mathrm{EI}_0}{\mathrm{W}}y = 162$

Next inserting the values for a, b, etc., into the substitution equations for the No. 10 point, it will be found that:

$$\sin^2\theta = .625$$
$$\cos^2\theta = .375$$
$$\tan^2\theta = 1.667 \text{ and } \tan\theta = 1.291$$
$$\sin\theta\cos\theta = .484$$
$$\sin\theta = .79057 \text{ so that } \theta = 52^\circ\, 14' = .912 \text{ radians.}$$

(*To be continued.*)

OSCILLATIONS OF A HIGH CHIMNEY. The *Engineer* draws attention to the investigations conducted by Professor Omori into the movements of the top of a high chimney when subjected to wind pressure. The chimney observed is built of reinforced concrete, 570 ft. high, and 26 ft. 3 in. inside diameter at the top, and is situated at Saganoseki. Wind velocities were recorded ranging from less than one mile per hour to a hurricane velocity of 78 miles. The amplitude of vibration at a velocity of 50 miles per hour was less than one inch, while at 78 miles per hour it was 7·32 inches. The maximum amplitude was in a direction at right angles to that of the wind. Professor Omori thinks that with wind gusts of 110 miles an hour, which occasionally occur in Japan, the amplitude would be at least 15 inches. The period of vibration was nearly constant for all velocities, varying only from 2·52 to 2·56 seconds.

GOVERNORS AND GOVERNING MECHANISM.

By A. Houlson.

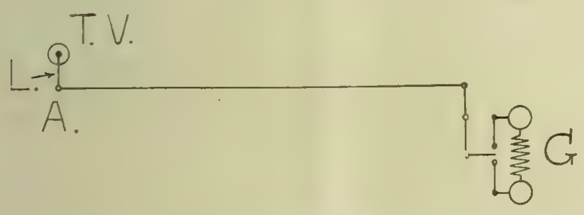
(*Concluded from page 158.*)

Governors for Commercial Vehicles.

Commercial vehicles and automobiles are not fitted with governors, except in special cases. Speed control under varying load is usually effected by hand operation of the throttle. Ignition is also frequently arranged to be capable of advancement or retardation by hand, preferably independent of throttling.

Governing of motor vehicles has certain advantages. It ensures that the vehicle will not be overdriven when running on a light load, thus preventing rapid deterioration of engine and transmission gear, due to excessive speed.

For night driving, in convoy without lights, it may be arranged so that all the lorries travel at the same pace, thus keeping nearly equidistant from each other. The principal disadvantages which accrue from the fitting of a governor is that the power of accelerating beyond normal speed in an emergency is absent, and gear changing is not so easy.



Governors.—Fig. 76.

In automobiles these governors are usually fitted on the cam shaft, but in commercial vehicles, where the speed of the crankshaft is not so high, they are sometimes mounted on the latter.. In some cases they are arranged on the side shaft.

A small governor G (Fig. 76) fitted on the camshaft of an automobile, and operating a circular throttle valve V, $2\frac{1}{4}$ in. diameter, placed in the induction pipe, exercised a force of .3 lb. at the end A of lever L, thus giving a twisting moment of .28 in. pounds on the throttle-valve spindle.

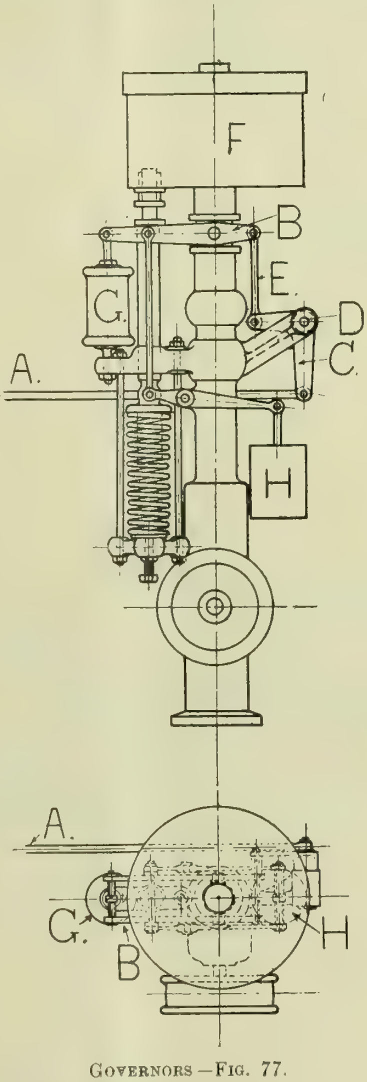
Governing of Air Compressors.

Governors for air compressors are generally composed of two controlling mechanisms: one for the speed control, and the other for regulating the air pressure. Fig. 77 shows a governor of this type. The rod A controls the cut-off. This rod is operated by the movement of the bell-crank lever C about the fulcrum D. The link E controls the bell crank C, and is connected to a floating lever B which is attached to the sleeve of the centrifugal governor F. The other arm of the floating lever B is connected to the piston G, which is in communication with the air pressure of the mains, and is held up by the weight H.

If the air pressure rises above the normal, the engine will have its supply of steam per stroke reduced. If the air pressure should fall, the supply of steam will be increased. If the pressure of air remains constant, the governor acts as an ordinary centrifugal governor.

Governors for Winding Engines.

There are two contingencies to be allowed for in the governing of winding engines. Firstly, in any reversing engine there is a possibility that the engine may require to be reversed whilst running at a high speed with the governor in the top position. The cut-off in the cylinder will be early, and the steam pressure available for reversing will be small. The method usually adopted to overcome this difficulty is to so arrange the governor gear that when the reversing lever is pulled over a temporary engagement is made with a lever on the governor lay shaft, and the governor is pulled down into its lowest position.

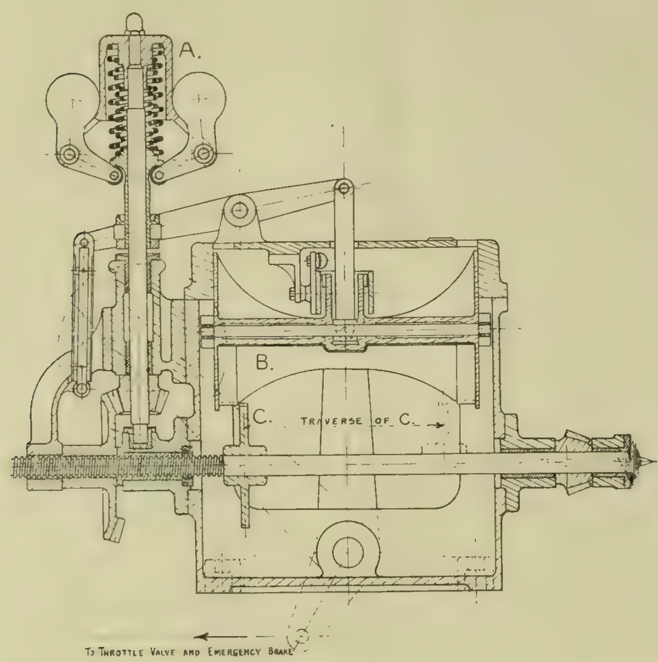


Governors —Fig. 77.

Secondly, overwinding must be provided against. If the engine gets out of control and the cage comes to the bank at full speed, instead of slowing down gradually, the brakes will probably not be powerful enough to prevent the cage from being pulled into the head gear.

One apparatus, Fig. 78, consists of a governor A, from which is suspended through levers a profile or cam B mounted on a swivel plate. A catch wheel C is mounted on a shaft under the profile, and has a traversing motion along the shaft, the total transverse motion representing the wind. As the speed

increases the profile dips lower, the catch wheel moving towards the centre to allow for this. If the speed is excessive, the profile dips into the teeth of the catch wheel, which causes the former to swivel on



Governors.—Fig. 78.

its axis, this action releasing a catch which shuts off the steam and applies the brakes.

The governor is fitted with three springs in place of the usual single spring. The weakest spring comes first into action alone, and then, after a certain upward movement of the sleeve, the second spring acts with it. Finally, the third spring comes into action, and all three springs are then acting together. The result is that the governor controls at slow speeds as well as at high speeds, which is, of course, essential if dumping of the downgoing cage is to be prevented.

Effect of Flywheel on Speed Regulations.

This has already been referred to. A graphical method of constructing the speed fluctuation curve from the torque diagram may be found interesting; see Fig. 79. Curve I. is the twisting moment diagram. Curve II. is the fluctuation of speed curve. The ordinate DE in Curve II. represents to scale the shaded area in Curve I., *i.e.*, the flux of energy into the flywheel. To construct Curve II. select a point O as pole and at a known distance Op from O erect a perpendicular. Mark off on this perpendicular distances pa, pb, etc., equal to ordinates AB, BC, etc., of Curve I. Draw AA parallel to Oa; BB parallel to Ob; and so on, thus obtaining Curve II. The scale of Curve II. is determined thus:—In Curve I. 1 in. horizontally along axis XX, represents F radians; 1 in. vertically represents an accelerating couple of G lb feet. Therefore I square inch area under Curve I. represents the energy FG foot lbs. The vertical energy scale of Curve II. is determined by the polar distance Op = H inches, that is, 1 in. vertically represents F G H foot lbs.

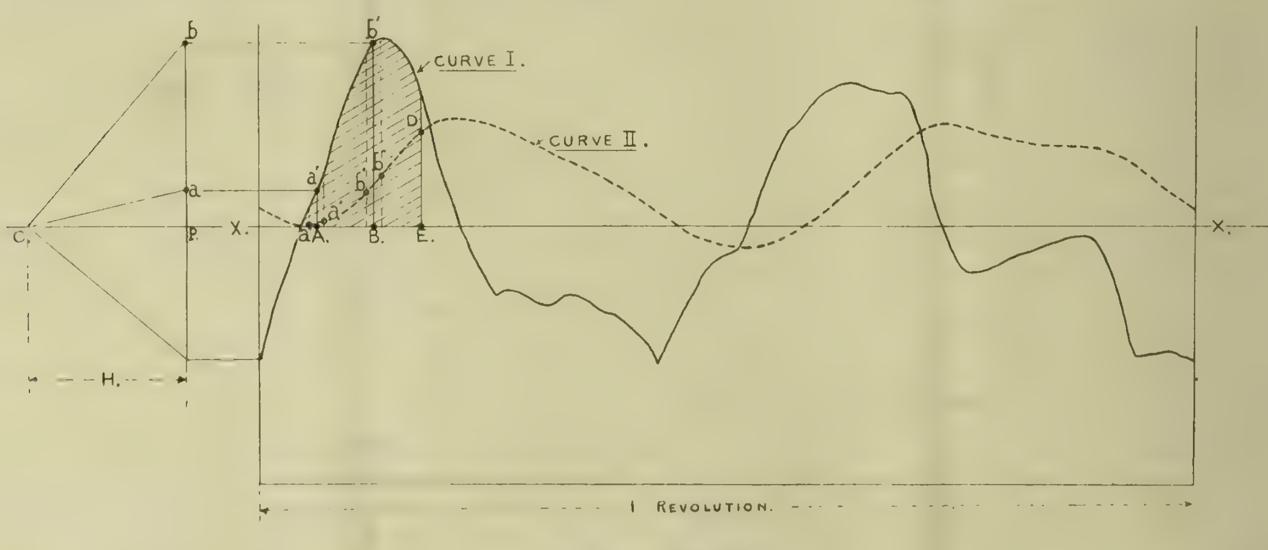
Now, change of angular velocity =

$$\frac{\text{Change of energy} \times \text{mean angular velocity of flywheel}}{2 \times \text{energy stored in flywheel at mean speed}}$$

so that the change of angular velocity corresponding to a change of energy of FGH foot lbs. is $\frac{FGH\omega}{2E}$ radians per second or $\frac{FGH\omega 60}{2E\,2\pi} = \frac{4{\cdot}77\,FGH\omega}{E}$ revs. per min.

The scale for speed fluctuation in curve II. is therefore:—1 in. $= \frac{4{\cdot}77\,FGH\omega}{E}$ revs. per min.

(*Concluded.*)



Governors.—Fig. 79.

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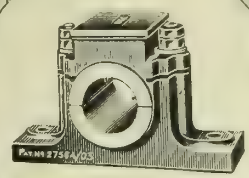

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Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 63 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 2 14	11 1 0	0 16 3 14	1 2 2 0	1 8 0 14	1 13 3 0	1 19 1 14	2 5 0 0	2 10 2 14	0
1	0 2 7	6 0 21	11 3 7	0 17 1 21	1 3 0 7	1 8 2 21	1 14 1 7	1 19 3 21	2 5 2 7	2 11 0 21	1
2	1 0 14	6 3 0	12 1 14	0 18 0 0	1 3 2 14	1 9 1 0	1 14 3 14	2 0 2 0	2 6 0 14	2 11 3 0	2
3	1 2 21	7 1 7	12 3 21	0 18 2 7	1 4 0 21	1 9 3 7	1 15 1 21	2 1 0 7	2 6 2 21	2 12 1 7	3
4	2 1 0	7 3 14	13 2 0	0 19 0 14	1 4 3 0	1 10 1 14	1 16 0 0	2 1 2 14	2 7 1 0	2 12 3 14	4
5	2 3 7	8 1 21	14 0 7	0 19 2 21	1 5 1 7	1 10 3 21	1 16 2 7	2 2 0 21	2 7 3 7	2 13 1 21	5
6	3 1 14	9 0 0	14 2 14	1 0 1 0	1 5 3 14	1 11 2 0	1 17 0 14	2 2 3 0	2 8 1 14	2 14 0 0	6
7	3 3 21	9 2 7	15 0 21	1 0 3 7	1 6 1 21	1 12 0 7	1 17 2 21	2 3 1 7	2 8 3 21	2 14 2 7	7
8	4 2 0	10 0 14	15 3 0	1 1 1 14	1 7 0 0	1 12 2 14	1 18 1 0	2 3 3 14	2 9 2 0	2 15 0 14	8
9	5 0 7	10 2 21	16 1 7	1 1 3 21	1 7 2 7	1 13 0 21	1 18 3 7	2 4 1 21	2 10 0 7	2 15 2 21	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 5·25	0 10·5	0 15·75	0 21	0 26·25	1 3·5	1 8·75	1 14	1 19·25	1 24·5	2 1·75	2 7	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 63 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 16 1 0	5 12 2 0	8 8 3 0	11 5 0 0	14 1 0 0	16 17 2 0	19 13 3 0	22 10 0 0	25 6 1 0	0
10	0 5 2 14	3 1 3 14	5 18 0 14	8 14 1 14	11 10 2 14	14 6 3 14	17 3 0 14	19 19 1 14	22 15 2 14	25 11 3 14	10
20	0 11 1 0	3 7 2 0	6 3 3 0	9 0 0 0	11 16 1 0	14 12 2 0	17 8 3 0	20 5 0 0	23 1 1 0	25 17 2 0	20
30	0 16 3 14	3 13 0 14	6 9 1 14	9 5 2 14	12 1 3 14	14 18 0 14	17 14 1 14	20 10 2 14	23 6 3 14	26 3 0 14	30
40	1 2 2 0	3 18 3 0	6 15 0 0	9 11 1 0	12 7 2 0	15 3 3 0	18 0 0 0	20 16 1 0	23 12 2 0	26 8 3 0	40
50	1 8 0 14	4 4 1 14	7 0 2 14	9 16 3 14	12 13 0 14	15 9 1 14	18 5 2 14	21 1 3 14	23 18 0 14	26 14 1 14	50
60	1 13 3 0	4 10 0 0	7 6 1 0	10 2 2 0	12 18 3 0	15 15 0 0	18 11 1 0	21 7 2 0	24 3 3 0	27 0 0 0	60
70	1 19 1 14	4 15 2 14	7 11 3 14	10 8 0 14	13 4 1 14	16 0 2 14	18 16 3 14	21 13 0 14	24 9 1 14	27 5 2 14	70
80	2 5 0 0	5 1 1 0	7 17 2 0	10 13 3 0	13 10 0 0	16 6 1 0	19 2 2 0	21 18 3 0	24 15 0 0	27 11 1 0	80
90	2 10 2 14	5 6 3 14	8 3 0 14	10 19 1 14	13 15 2 14	16 11 3 14	19 8 0 14	22 4 1 14	25 0 2 14	27 16 3 14	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	28 2 2 0	56 5 0 0	84 7 2 0	112 10 0 0	140 12 2 0	168 15 0 0	196 17 2 0	225 0 0 0	253 2 2 0	281 5 0 0	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 64 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 2 24	11 1 20	0 17 0 16	1 2 3 12	1 8 2 8	1 14 1 4	2 0 0 0	2 5 2 24	2 11 1 20	0
1	0 2 8	6 1 4	12 0 0	0 17 2 24	1 3 1 20	1 9 0 16	1 14 3 12	2 0 2 8	2 6 1 4	2 12 0 0	1
2	1 0 16	6 3 12	12 2 8	0 18 1 4	1 4 0 0	1 9 2 24	1 15 1 20	2 1 0 16	2 6 3 12	2 12 2 8	2
3	1 2 24	7 1 20	13 0 16	0 18 3 12	1 4 2 8	1 10 1 4	1 16 0 0	2 1 2 24	2 7 1 20	2 13 0 16	3
4	2 1 4	8 0 0	13 2 24	0 19 1 20	1 5 0 16	1 10 3 12	1 16 2 8	2 2 1 4	2 8 0 0	2 13 2 24	4
5	2 3 12	8 2 8	14 1 4	1 0 0 0	1 5 2 24	1 11 1 20	1 17 0 16	2 2 3 12	2 8 2 8	2 14 1 4	5
6	3 1 20	9 0 16	14 3 12	1 0 2 8	1 6 1 4	1 12 0 0	1 17 2 24	2 3 1 20	2 9 0 16	2 14 3 12	6
7	4 0 0	9 2 24	15 1 20	1 1 0 16	1 6 3 12	1 12 2 8	1 18 1 4	2 4 0 0	2 9 2 24	2 15 1 20	7
8	4 2 8	10 1 4	16 0 0	1 1 2 24	1 7 1 20	1 13 0 16	1 18 3 12	2 4 2 8	2 10 1 4	2 16 0 0	8
9	5 0 16	10 3 12	16 2 8	1 2 1 4	1 8 0 0	1 13 2 24	1 19 1 20	2 5 0 16	2 10 3 12	2 16 2 8	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	5·34	10·68	16·02	21·36	26·70	1 4·04	1 9·38	1 14·72	1 20·06	1 25·4	2 2·74	2 8	

Weights of Lengths of Rolled Steel Sections.

Beam 15 in. × 6 in. × 64 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	2 17 0 16	5 14 1 4	8 11 1 20	11 8 2 8	14 5 2 24	17 2 3 12	20 0 0 0	22 17 0 16	25 14 1 4	0
10	0 5 2 24	3 2 3 12	6 0 0 0	8 17 0 16	11 14 1 4	14 11 1 20	17 8 2 8	20 5 2 24	23 2 3 12	26 0 0 0	10
20	0 11 1 20	3 8 2 8	6 5 2 24	9 2 3 12	12 0 0 0	14 17 0 16	17 14 1 4	20 11 1 20	23 8 2 8	26 5 2 24	20
30	0 17 0 16	3 14 1 4	6 11 1 20	9 8 2 8	12 5 2 24	15 2 3 12	18 0 0 0	20 17 0 16	23 14 1 4	26 11 1 20	30
40	1 2 3 12	4 0 0 0	6 17 0 16	9 14 1 4	12 11 1 20	15 8 2 8	18 5 2 24	21 12 3 12	24 0 0 0	26 17 0 16	40
50	1 8 2 8	4 5 2 24	7 2 3 12	10 0 0 0	12 17 0 16	15 14 1 4	18 11 1 20	21 8 2 8	24 5 2 24	27 2 3 12	50
60	1 14 1 4	4 11 1 20	7 8 2 8	10 5 2 24	13 2 3 12	16 0 0 0	18 17 0 16	21 14 1 4	24 11 1 20	27 8 2 8	60
70	2 0 0 0	4 17 0 16	7 14 1 4	10 11 1 20	13 8 2 8	16 5 2 24	19 2 3 12	22 0 0 0	24 17 0 16	27 14 1 4	70
80	2 5 2 24	5 2 3 12	8 0 0 0	10 17 0 16	13 14 1 4	16 11 1 20	19 8 2 8	22 5 2 24	25 2 3 12	28 0 0 0	80
90	2 11 1 20	5 8 2 8	8 5 2 24	11 2 3 12	14 0 0 0	16 17 0 16	19 14 1 4	22 11 1 20	25 8 2 8	28 5 2 24	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	28 11 1 20	57 2 3 12	85 14 1 4	114 5 2 24	142 17 0 16	171 8 2 4	199 19 3 24	228 11 1 16	257 2 3 8	285 14 1 4	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

PORTABLE ELECTRIC TOOLS.

By E. Austin.

The use of portable electric tools, such as drills and grinders, is rapidly increasing. Before the war many of these tools were made in Germany, but of late a considerable number of new British-made tools have been introduced. Of course, portable compressed air tools are very satisfactory and are largely used in shipyards and general engineering establishments, but whereas electric tools can be worked from any ordinary supply system, compressed air tools demand the installation of a special compressed air plant.

The development of satisfactory electric tools has been a somewhat tedious process, and many of the earliest types put upon the market left much to be

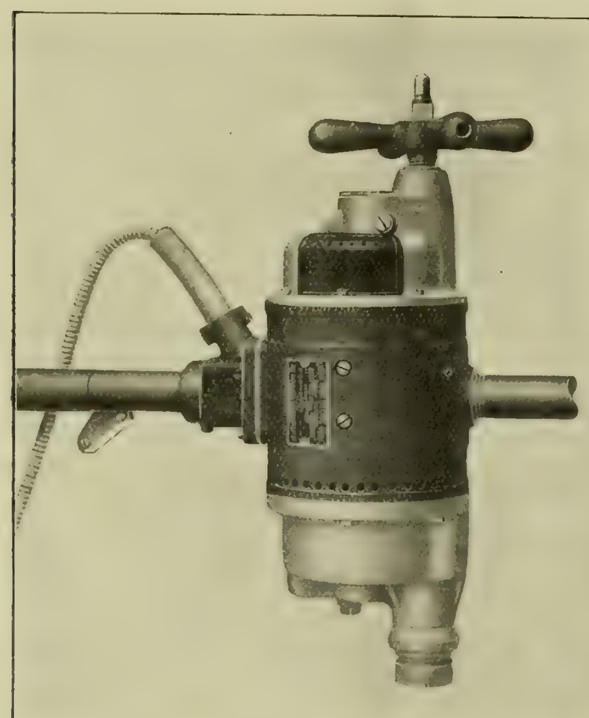


Fig. 1.—A Heavy Duty Electric Drill with a Feed-Screw Attachment (The Consolidated Pneumatic Tool Company.)

desired. The motors frequently gave trouble owing to excessive heating and sparking at the brushes. Manufacturers who first undertook to make portable electric tools apparently failed to recognise that the conditions under which such tools operate are in many cases extremely arduous, and they supplied motors altogether unsuitable for the work. A common fault in the early days of the industry was that the motors were unduly heavy, thus making the tools difficult to operate. In attempting to cut down some electric tool, designers went too far, with the result that heating and sparking troubles developed. Great improvements were made, however, in the working of portable electric tools by the introduction of forced ventilation, which was first used by Mr. W. O. Duntley, of the Chicago Pneumatic Tool Company. By simply attaching a fan to the motor armature it became possible greatly to reduce the weight without involving excessive working temperatures. The introduction of forced ventilation has done more than anything else to make portable electric tools successful, for the passage of air over the armature and field windings, during the period the tool is at work, enables a smaller and lighter motor to be employed than would otherwise be permissible.

As electric tools are driven by series-wound motors, the speed varies with the load. Thus, when a drill, for example, is removed from the work, the speed of the armature greatly increases, thereby causing the fan to draw in a large volume of air. Heavy overloads can therefore be dealt with for

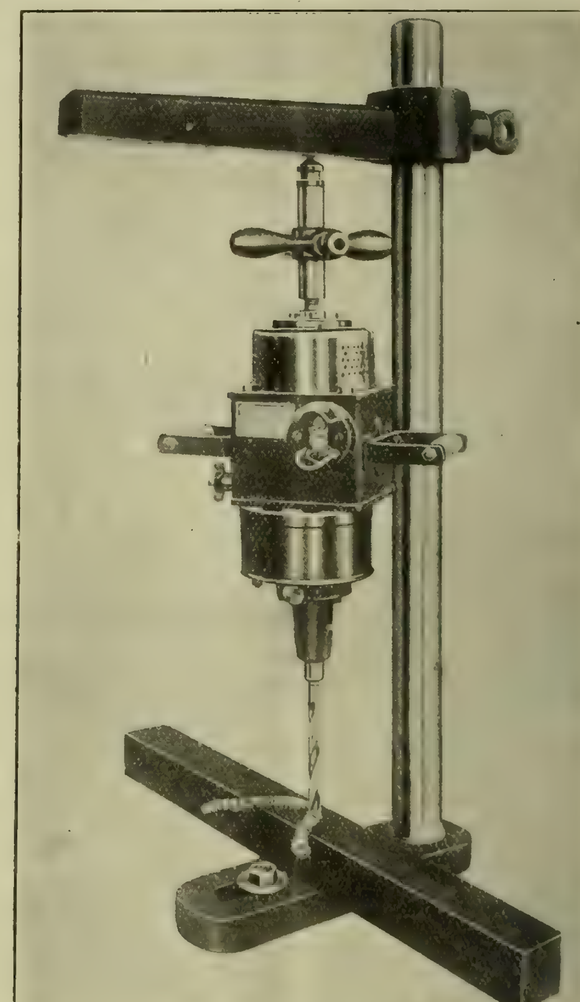


Fig. 2.—A "Wolf" Electric Drill with Feed-Screw and Stand.

short periods without unduly raising the working temperature. At one time it was common practice to incorporate a slipping clutch between the armature and tool, with a view to limiting the load on the motor to a predetermined value, but the majority of electric tool makers have now abandoned this practice, it having been found that properly designed motors will withstand all the loads thrown upon them. A much more crude scheme adopted by some makers in the early days of the industry was to provide some sort of warning device, such as an electric bell to give warning to the operator when the working current exceeded a certain value, but needless to say, electric tools stood

little chance of gaining popularity whilst such devices were requisite. Modern portable electric tools are entirely devoid of all such arrangements, the motors being designed to withstand rough usage, and the windings being well protected from dirt and moisture. Ball bearings are also fitted, and those parts not associated with the magnetic circuit, such as end covers, are frequently made of aluminium. Of course, all firms do not construct electric tools on exactly the same lines, but in general it may be said that the outer shell of a D.C. motor may be of cast steel or cast iron, depending upon how far weight is an important consideration, cast iron involving greater weight than cast steel by reason of its lower magnetic qualities. When a tool is intended to work on alternating current exclusively, or to be suitable for either direct current or alternating current, the magnetic circuit must be laminated. The armature must, of course, be laminated in any case. The motor part is divided from the gearing in the case of most drills by means of a diaphragm, which in addition to preventing the ingress of oil to

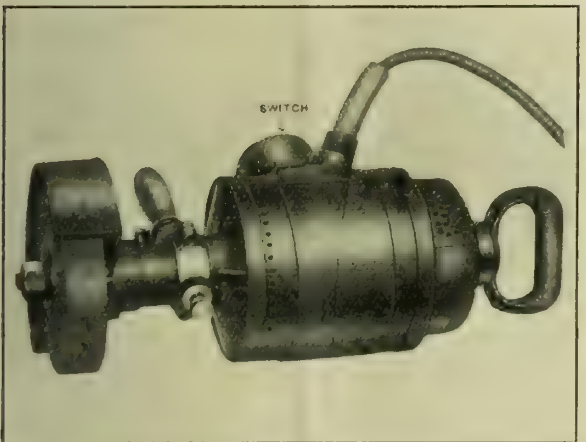


Fig. 3.—A Portable Electric Grinder. (The Consolidated Pneumatic Tool Company.)

the armature, carries the bearings for the gears. The lower end of the gear case is covered by means of a dished casting which carries the opposite bearings for the gear and tool socket. Sometimes the drill spindle is at the side of the motor, as in Fig. 1, but many drills are made with the drill spindle in the centre as shown in Fig. 2. Some drills are also made so that they can be used with a feed screw or breast-plate, the screw or plate being attached to the machine as desired.

A valuable auxiliary to the electric drill is the magnetic drill post, which obviates the necessity of fixing the post by ordinary mechanical methods. On switching on the current, the post is immediately held firmly in position, and when the work is reasonably flat these magnetic drill posts are the means of saving much time and labour. Electric tools are more efficient than compressed air tools, and as the current is supplied to the motors through small flexible wires, they are on the whole more easily handled. Portable electric grinders, as shown for example in Fig. 3, are now largely used in engineering workshops. A grinder of this sort may be employed for a variety of purposes, ranging from fettling castings and smoothing off riveted surfaces, when flush rivets have to be driven, to the more refined operation of accurately grinding finished work. Many kinds of electric grinders are now upon the market. There are, for example,

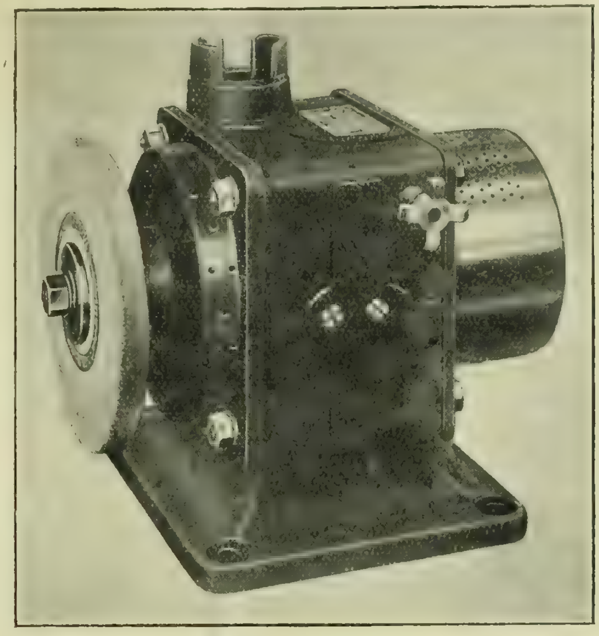


Fig. 4.—A "Wolf" Electric Bench Grinder.

grinders composed of an independent motor and grinding wheel, the former transmitting the power to the latter through a flexible shaft. This principle is also applicable and is applied to other tools, such as drills, and it offers the advantage of enabling the motor to be larger and more powerful

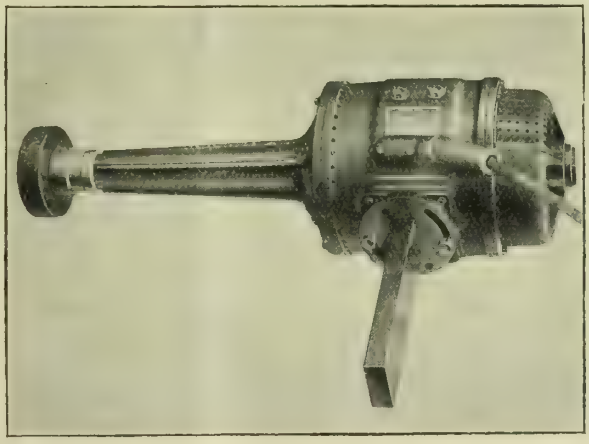


Fig. 5.—An Electric Toolpost Grinder. (The Consolidated Pneumatic Tool Company.)

than a motor that has to lifted on to the work by hand. Weight under these conditions is of little importance, since the motor can be provided with wheels or mounted on a trolley so that it can readily be shifted from place to place. On the other hand, the flexible shaft introduces a certain amount of

loss, which is eliminated when the grinding wheel is mounted directly on the armature spindle. There are also electric bench grinders as shown in Fig. 4, a form of machine which can readily be used for polishing by fitting a polishing buff instead of the grinding wheel. Another useful and very widely used type of electric grinder is the tool post grinder, see Fig. 5, machines of this sort being supplied for internal or external grinding on a lathe, tool grinding on a milling machine, and surface grinding on a shaper or planer.

CURRENT FUEL PROBLEMS.

At the present time gas undertakings are receiving complaints about the dearness of gas and its poor quality. Comparisons are drawn between the state of things in both respects now and in the years previous to the war. The gas undertakings have a complete answer to these complaints, and let us see what that answer is.

The complaint as to the gas supplied to the consumers is twofold:—

(1) That it is too dear;

(2) That it is poor and without the heat it used to possess.

1. The price of gas in 1913 for the greater part of London was 2s. 6d. per 1,000 cubic feet; in 1919 it was 4s. 8d. per 1,000 cubic feet; but consider the cost of coal and labour to one of the largest undertakings:—

Coal, which in 1913 cost 16s. per ton, including freight charges, can only be bought now at a rate of over 40s. per ton. Thus, while the price of gas has risen by 86 per cent, the price of the raw material from which gas is manufactured has risen by as much as 150 per cent.

At the same time, the cost of labour has mounted up by nearly 120 per cent. These figures speak for themselves.

Taking the cost of coal charges by one typical company, let us consider the percentage of the return of residuals obtained therefrom during the last five years compared with the previous period of five years. The figures work out at 66 as compared with 82. Put in other words, from every £100 worth of coal bought during the last five years, the company recovered £66 in the form of residuals, whereas during the previous five years it recovered £82.

The return for coke alone during the corresponding periods was only 40 per cent of the cost of the coal as against 50 per cent.

In the manufacture and sale of gas there is no such thing as profiteering. It is, indeed, absolutely impossible. There appears to be an impression abroad that the profits derived from the sale of residuals are not included in the profits distributed as dividend. That impression is wholly erroneous, and may be dismissed from the average consumer's mind as a mere figment of imagination. Instead of being a thing of dark mystery, the balance sheet of any gas undertaking is quite clear and open. The average dividend of the two largest Metropolitan Gas Undertakings, for instance, is only 3 per cent, and that 3 per cent embraces all returns of profit from the sale of the gas, the hire of the meters, stoves, and fittings, and the sale of residuals. Practically the same holds good for every other gas undertaking throughout the country.

Then there is the question of the sliding scale and its temporary suspension. The sliding scale, put briefly, worked out thus: When the price of the gas to the public was raised, the dividend accruing to the shareholders was automatically reduced, and *vice versa*. When the price of gas was reduced, the shareholders benefited by an increased dividend. Therefore, the gas companies had every inducement to supply cheap gas because a reduction of price was a condition precedent to an increased dividend—a safeguard to the public not common in trade or commerce.

For the sliding scale there has recently been substituted a temporary order by the Board of Trade, allowing the undertakings, on application to that Department, to charge for gas such a price as will allow them to pay a very moderate dividend—far below that paid in pre-war days. It is understood that the recommendations contained in the report of the Fuel Research Board on Gas Standards, that gas shall be charged for according to its thermal or heat value and not according to its cubical capacity, will be embodied in a Bill to be introduced into Parliament by the Board of Trade next year.

The test of thermal value is a great advantage to the consumer, and there will be a penalty on the undertaking if its gas is below the standard fixed by the department. The consumer will then pay for the heat actually supplied.

A word may be added with regard to the complaint that the gas is at present poor in quality. Owing to the necessity for all gas undertakings to conserve coal, an order was issued by the Board of Trade allowing gas undertakings generally to reduce the quality of their gas. As a matter of fact, figures have been extracted which show that the reduction actually made in heat value in the metropolis during 1918 was only 7 or 8 per cent below that of the gas supplied in 1913. During the war it might be remarked that benzole was extracted from the gas for the purposes of obtaining the necessary material for making high explosives, but this again was a very small matter when considered in relation to heat value. The extraction of benzole would in no case amount to a reduction in the calorific value of the gas by very much more than 2½ per cent.

Therefore, we see that the charge so confidently advanced against the gas undertakings fails on both grounds. Generally speaking, gas is dear at the present time for two reasons, and two reasons only. Those are the high price of coal and the increased expenditure on labour.

PRODUCER GAS FOR MOTOR VEHICLES.

By D. J. Smith.

For several years past, engineers have regarded with misgiving the steady advance in the price of liquid fuel, and the continuous inflation of oil share prices and the combination of great oil-trading organisations, give little hope of any reduction, even if the output is increased sufficiently to balance the demand. The author has read quite recently diametrically opposite statements as to the oil resources of the world and the possibility of maintaining a supply equal to all demands, and he is doubtless in the same position as many other engineers in that he does not know how near either statement is to the facts.

One thing, however, seems certain, and that is that at the present time the production of internal-combustion engines using liquid fuel is rapidly outpacing the supply of fuel necessary to

run them. The output of motor vehicles in Great Britain is at present a somewhat nebulous quantity, but it promises to be great. The figures for the United States of America show that for the month of April, 1919, the output of 32 factories reached a total of 7,084 vehicles daily, which, allowing 300 working days, is equal to 2,125,000 vehicles per year. When manufacturers recover from the disorganisation caused by the war, this will probably be considerably increased. Disregarding the vehicles already running, and assuming a consumption of only 200 gallons of petrol per vehicle per annum, this new output alone will require over 400,000,000 gallons increase in the fuel supply to keep it running. At the present time, over two-thirds of the world's total output of petroleum comes from the United States, and, bearing this in mind, the author was much interested in an official report issued by the U.S. Government Printing Office in 1918, termed "Mineral Industries of the U.S., Petroleum, a Resource Interpretation," and he gives the following quotation :—

> "The output of 1917 cannot be maintained throughout 1918 without the arrival of critical conditions, and a continuation through 1919 is impossible. While the total demands for petroleum are increasing at a growing rate, the rate of production is slowing, and there is scant hope of increasing supplies from Mexico."

This certainly does not point to lower prices, but it may imply the early cessation of the export of petroleum by the United States. Other sources of supply will be available, but these are hardly likely to affect prices, as they will probably come under the control of the existing oil-marketing organisations, which have so far held the motor industry as in a vice. Even benzol, from which so much was expected, is now being exploited, and a letter of protest from the secretary of the Automobile Association and Motor Union appeared in the *Motor Trader* of July 30th, 1919, stating that the petrol companies were distributing a product called benzol at a price which did not allow it to be retailed at less than 3s. per gallon.

If the motor vehicle industry is to develop as it should do, cheaper fuel is essential. Quite apart from the question of cost, however, it is very inadvisable that such a vast industry should depend on what is practically a single source for its fuel supply, and on a fuel which has to be largely imported from countries which take little from Great Britain in return, and which also has to suffer from so much juggling in handling, as witness the great difference between the present prices in America and here.

With vehicles using petrol, the fuel costs can, apart from a lower price, only be reduced by a greater economy in its use. This does not appear very probable, as the internal-combustion engine seems to have reached the limit of its economy for commercial work, and further savings can only be looked for in the direction of reducing the vehicle weight in proportion to the load carried.

A widening of the field of suitable fuels must be all to the good of both the vehicle user and the manufacturer, and must have a steadying effect on prices and largely increase the use of mechanically-propelled vehicles in places where liquid fuels are not readily available. A greater part, if not all, of the vast sums now being spent abroad for petrol could be saved to this country if solid fuels were used on all heavy vehicles, as the home production of liquid fuel might then be sufficient to supply the lighter vehicles. In any case, the author does not consider that the automobile industry of this country will rest on a sound basis until it can rely entirely on home produced fuels. Practically, it does not cost the United States anything at all for fuel to run all the vehicles in the country. Even the comparatively small labour cost of refining and handling the oil over there must be more than covered by the increased price (excluding freight) at which the fuel is sold here, and Great Britain is, therefore, handicapped by having to pay the fuel bill of the United States as well as its own. The motor vehicle saved the situation in the recent railway strike, but it did so on imported fuel. A serious and extended labour dispute in the States might gravely affect the liquid fuel supply here. Motor transport will very shortly be a greater asset to this country than its railways, and all possible steps should be taken to secure a safe fuel supply for it.

Solid fuels present the only method whereby the high cost of liquid fuels can be countered and the general position made less unsatisfactory, and these can be used without destroying any material from which liquid fuels might be extracted. For instance, coke, charcoal, and dried peat represent the residue left after the liquid fuels have been extracted, so the utmost value is got out of the material used in providing fuel for both light and heavy motor vehicles. In the case of anthracite, there are practically no volatile constituents, so this fuel, if used directly, entails no loss to the liquid fuel supply. It has long been the author's firm opinion that every material from which any form of liquid fuel is obtainable should, before being used, be subjected, as far as it is possible, to the process necessary to extract such fuel. The residue is frequently as valuable, when properly treated, as the complete fuel was in the original state, weight for weight, and the volatile constituents which are recovered are often alone more valuable than the fuel from which they were obtained. The best known example is the distillation of coal in the process of making coal gas. One ton of coal would propel a 5-ton steam wagon about 160 miles, the fuel then being completely destroyed. If subjected to distillation, the one ton of coal would give 13,000 cubic feet of coal gas, and taking 250 cubic feet of this gas as equal to one gallon of petrol, this would propel a 5-ton internal-combustion engined vehicle 312 miles. But after allowing for the fuel used for the retort, about 10 cwt. of coke would still remain, and at 3 lb. of coke per mile, a 5-ton producer gas vehicle would run a further 373 miles on this, or a total of 685 road-miles as against 160 miles on one ton of coal burned directly. In addition to this, a large quantity of very valuable by-products would remain. The author has taken no account of benzol, as he has calculated the gas at its full calorific value, but by extracting the benzol even better results would be given from an economic point of view. The utilisation of 10 cwt. of coke used in a vehicle fitted with a portable producer gas plant would, therefore, give over double the mileage obtained from the direct combustion of one ton of coal, which in addition causes the loss of all its valuable volatile constituents.

The author does not propose to go into the question of producer efficiency, composition of gases, etc., as these are quite apart from the object of this paper, and are fully dealt with in all the standard works on gas engines and producers. That there is no doubt about engines being able to run satisfactorily on producer gas, the millions of horse power already in use amply prove, and few engineers would argue that there would be any experiment in manufacturing a motor vehicle engine to use this fuel.

The stumbling block up to the present has been the producer, and it is to the method in which the producer has been modified for use on motor vehicles that the author proposes to devote himself in this paper. Whether the efficiency of a producer is 95 per cent or 75 per cent is not of vital importance when there is such a wide difference in price between petrol or paraffin and the fuels used in the producer. The author has, however, kept efficiency as the chief consideration in the design of his producer, and he can state definitely that this is very high, as would be anticipated by consideration of the method of working.

Before proceeding further, the main advantages and disadvantages of the use of producer gas as a fuel for vehicle propulsion may be stated :—

Advantages.

(1) It allows the use of home produced fuels, fuels, moreover, of which some are regarded at present largely as waste products, such as anthracite duff. Non-caking bituminous coal or coke can be used, but as there are many uses for them, while there are few for the duff, there is no reason to use any other, so long as it is available at low prices.

(2) It is safe, and eliminates all chances of fire, and would greatly reduce the insurance premiums on vehicles and the premises in which they are stored.

(3) Compared with coal gas, it does not call for labour in its preparation, or the consumption of fuel of commercial value in its production.

(4) It eliminates the perishable gas bag, which generally renders it impossible for a vehicle to get under a crane for loading or unloading goods.

(5) It allows a vehicle to travel the same distance as on petrol without taking in fresh fuel.

(6) It is a fuel of almost unvarying quality and eliminates mixture troubles and the need for more or less troublesome mixing valves.

(7) It is the cheapest source of power which can be adapted to motor vehicles know at present, and with coal at 40s. per ton is equal to petrol at $2\frac{1}{2}$d. per gallon when used in the same engine.

(8) It is lighter than a compressed gas installation and occupies less room, and eliminates expensive compressing costs.

(9) It requires no pressure, and there is therefore no danger. The pressure in the plant is always less than atmospheric, so if there is any leakage, it is of air inwards.

Disadvantages.

(1) The time taken to start from cold : this averages from 15 to 20 minutes, but the fire will keep alight all night if desired and can be ready for a start in about four to five minutes the next morning.

(2) The weight of the plant over and above that of the fuel, which for a 50 H.P. engine is about 2 cwt. The tare of the average 3-ton lorry is about 3 tons 15cwt., so this is not a high proportion.

(3) The necessity for an occasional cleaning of the plant. This involves a wash out of the scrubber every morning, which takes about five minutes and can be done while the fire is being lighted, so means no loss of time. The plant should be started up in a well ventilated space, as the gas is harmful if inhaled in quantities for any length of time. Once the plant is going, there is no escape of gas.

(4) The time, three or four minutes, taken to start after any lengthy stoppage.

(5) An increase of 75 per cent in weight of fuel (including water) to cover any given distance, as compared to petrol, unless the engine is adapted to give higher initial compression, in which case the disparity in weight is considerably reduced.

At the present time only two types of vehicles use solid fuel, the steam vehicle directly and the electric vehicle indirectly. Both of these are noted for their low fuel cost, and this has much to do with the growing popularity of these types. In the case of the steam vehicle, a low upkeep cost, due to the vehicle being designed for its work with no attempt to incorporate the latest pleasure car practice (probably quite unsuited for heavy vehicle work) is also a powerful factor, but the cheapness of fuel is a great consideration.

The user generally only regards the value, not the weight, of the fuel used, and it would be a very great drawback to the internal-combustion vehicle if, in order to get equally cheap running, it had to consume the same weight of fuel as the steam vehicle. A 5-ton steam lorry running on rubber tyres and weighing, with its load, 12 tons, should not consume more than 1 cwt. per eight miles. With coal at 50s. per ton, this is equal to 0·31d. per gross ton-mile. A 5-ton petrol lorry, weighing, with its load, nine tons, would consume one gallon per six miles, and this with petrol at 3s. per gallon is equal to 0·66d. per ton-mile, or more than twice the cost of the steam vehicle. Owing to the great difference in the weights of the vehicles, it is necessary to take gross weight for comparison, but taking the net load of the two vehicles, the cost works out at 0·75d. per ton-mile for the steam vehicle and 1·2d. for the petrol vehicle. The steam vehicle is, however, using 14 lb. of fuel per mile as against 1·3 lb. for the petrol vehicle, but as the cost of a ton of coal is little more than that of 1 cwt. of petrol, that is, 50s. to 42s., this is not considered.

With such a great disparity in the prices of the fuels, it is quite obvious that the petrol vehicle, even with its much more economical prime mover, cannot compete with the steam vehicle in cost of fuel. By the use of producer gas, the internal-combustion vehicle is able to use the same fuels as the steam vehicle, and, owing to its higher efficiency, to consume far less in proportion to any given work.

Unfortunately, the chief data relating to producer gas deal with the weight of fuel per brake horse power, and it is somewhat difficult to transform this into ton-miles in comparison with a steam vehicle. It is, however, well known that small steam motors are comparatively extravagant in fuel, and it is doubtful if the consumption is less than 3 lb. per horse power per hour. A petrol engine, taken in its "commercial state" as usually found in motor vehicles, would consume 1 lb. of petrol per horse power per hour. An engine designed for producer gas would probably not use more than 1·2 lb. per horse power per hour, taking good anthracite as a basis, so it can be seen that producer gas provides a fuel as low in price as that used by steam vehicles and nearly as low, measured in quantity for any given work, as that used by petrol vehicles.

The comparative costs are given in Table I. :

Table I.

	5-ton Steam.	5-ton Petrol.	5-ton Producer Gas.
Price of fuel	50/- per ton	3/- per gall.	55/- per ton
Gross load	12 tons	9 tons	9·5 tons
Lb. of fuel per mile ...	14	1·33	1·56
Lb. per nett ton-mile ..	2·8	0·26	0·312
Cost per lb., pence.....	0·268	4·5	0·294
Cost per gross ton-mile .	0·31	0·66	0·048
Cost per nett ton-mile .	0·75	1·2	0·091
Equivalent cost of petrol per gallon	1/6	3/-	2·6 pence

This indicates that by using producer gas in an internal combustion engined vehicle, the steam vehicle is no longer the cheapest in fuel cost, although the fuel for the producer gas vehicle is taken at a higher figure, the current market figure at this time.

It is in the weight of fuel, however, that the greatest saving is accomplished; the steam vehicle uses about nine times greater weight of fuel per mile than the producer gas vehicle. Assuming a journey of 100 miles, the steam vehicle would therefore have to carry over half a ton more fuel than the producer gas vehicle in order to accomplish the full distance. If other things were equal, this would seem to point to the extinction of the heavy steam vehicle, but this is not likely to happen until the makers of internal-combustion vehicles build a vehicle which can take the place of the steamer with its extremely low upkeep and repair cost and great reliability. This is the type of vehicle which the author hopes to see adopted for the use of producer gas, and which is dealt with later in the paper.

In view of the fact that the railways of the country have practically broken down, there must be an enormous extension in the use of heavy road transport if industry is to carry on, and it is essential that this transport should be run as economically as possible and also in such a way as not to still further encroach on the fuel supply of those vehicles for which liquid fuel is essential. The author, therefore, considers the application of producer gas to vehicle propulsion as a matter of first importance, especially in view of the fact that this method of propulsion is accompanied by the following advantages in the wording of the Inter-Departmental Committee on Gas Traction (1919).

(1) Lowest known fuel cost.

(2) Large radius of action without recourse to compression or the use of containers as with coal gas.

(3) Use of home produced solid fuels.

(4) Low cost of upkeep.

The method in which it may successfully be applied can now be dealt with.

Producer Gas for Motor Vehicles.

The application of producer gas to motor vehicle propulsion has already attracted much attention. It is very difficult to state definitely at this time who originated the idea, but it seems very probable that the first internal-combustion engined vehicle that ever ran on common roads was driven by producer gas. In 1819 David Gordon, who was the patentee of a portable gas producing apparatus, endeavoured to form a company to build mail coaches and other carriages on his system, using a gas vacuum engine. Details of Gordon's apparatus are meagre, but it is described as comprising a "carbonic oxide" furnace. Coal gas had just come into use at that period, and as Gordon was in collaboration with Murdoch at Soho, his gas producer might have been a carbonising apparatus as used for the production of coal gas. There is no record that Gordon ever propelled a vehicle on his system.

In 1823, Samuel Brown patented a vehicle propelled by gas, and a vehicle constructed on his patents is said to have ascended Shooter's Hill at high speed. Brown's engine we are conversent with, but what type of gas producer he used is not known to the author. This, however, would appear to be the first internal-combustion vehicle which ever ran. The high consumption of Brown's engine would put gas bags or cylinders of compressed gas out of the question, even if such articles were available at that date. Brown was fully alive to the possibility of gas propulsion of boats, and ran a boat on the Thames using his apparatus, and formed a company called the Canal Gas Engine Company, but this soon went into liquidation. Brown was undoubtedly before his time and shared the fate of so many other inventors who lived before the world was in need of their work.

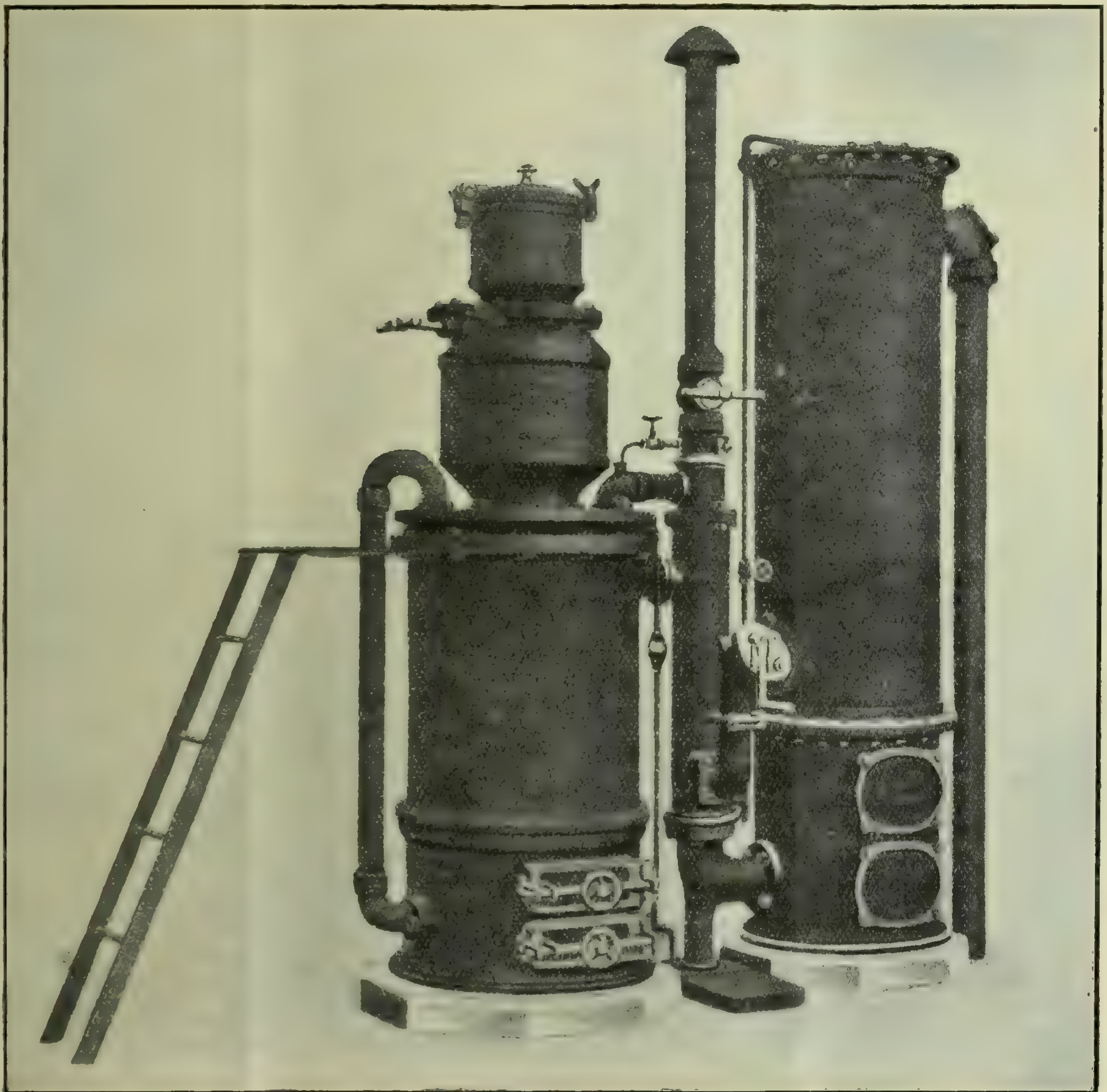
Producer gas, as applied to internal-combustion work, did not, however, receive much attention until stationary gas engines began to be built in large sizes, and were, therefore, costly to run on town gas, and could not, moreover, be used at all where no public gas supply was available. It is true that gas producers, or as they were termed, carbonic oxide furnaces, were used for heating purposes and many patents were taken out about 1860 for such furnaces, but this use is not within the scope of this paper. The success attending the use of stationary producer gas engines and the very low cost of running them were the reasons which led many engineers, including the author, to see if this source of power could not be sucessfully adapted to motor vehicle propulsion.

The problem of running the engine of a motor vehicle on producer gas is a very different one from that of running a stationary engine where weight and size of plant need hardly be considered and flexibility is not important. Provided that room could be found and the vehicle could carry the weight involved, it would be quite possible to use any form of stationary producer on a motor vehicle as far as furnishing the gas to the engine is concerned. A 40 to 50 H.P. stationary producer plant would weigh about three tons, and would fully occupy the loading space of the vehicle. It would also require about $1\frac{3}{4}$ gallons of

water per horse power, or say, 680 lb. per hour for its operation. Even if by the use of pressed steel the weight of the producer plant was reduced as far as possible, the size and high consumption of water would still remain and would render its use impracticable.

Failure to adapt gas producers to motor vehicle work has chiefly been due to the fact that stationary plant has been taken as a basis, and every effort has been concentrated on reducing it in size and weight, while the features which render the ordinary producer impossible for motor vehicle work still remained. As this paper deals with the adaptation of apparatus to use this form of fuel, it will be necessary to point out these features and to indicate why they must be eliminated before it can be sucessfully applied to vehicle work. Fig. 1, Plate I, shows a stationary gas producer of good design of about 30 H.P. The size is indicated by the ladder on the side of the producer, and the proportion of the scrubber in relation to the producer should be noticed. A producer of this type depends entirely for its satisfactory working on the care and attention given by the man in charge. It has no moving or mechanically-operated parts. The fire having been lighted, fuel is fed into the producer by the attendant until the hopper is full. Only a thin layer of the fuel is burning at the bottom, the remainder of the fuel above this being exposed to the full heat of the fire, and all the hot gases are drawn up through it. If there are any volatile constituents in the fuel, and even in good anthracite there is a certain proportion, this is the best possible method of distilling them off, but the worst possible method for direct use, as any portion of these volatile constituents would gum up the engine; a very large scrubber has therefore to be fitted, in order to eliminate them, and this requires a large quantity of water, usually about $1\frac{1}{2}$ gallons per brake horse power per hour. It will thus be clear that if a producer which is liable to give off tar or volatile matter is used on a motor vehicle, it would not be practicable to fit a scrubber large enough to deal with the gas efficiently, nor would it be possible to carry the quantity of water required for anything but a very short run.

(To be continued.)



Producer Gas for Motor Vehicles.—Fig. 1.

LINE CHARTS (for Solving Engineering Formulæ). By Ernest W. Tipple. 2s. net. Copies may be obtained from the Technical Secretary, Leeds Sub-branch of the Association of Engineering and Shipbuilding Draughtsmen, 28, Arkington View, Hunslet, Leeds.

Everyone will agree with the author when he states that the line chart for solving engineering problems effects a great saving of time and trouble. The present book has developed from two lectures, recently given before the Leeds Sub-branch of the Association of Engineering and Shipbuilding Draughtsmen. Some 34 diagrams are given in the book, showing a very diversified use of line charts. The book is obviously of great value to draughtsmen in particular and engineers in general.

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(*Continued from page 51.*)

In another form of pulverising mill, balls, which may be of specially hard steel, but which are sometimes of a specially hard form of stone that is found in balls, at certain parts of the coast, revolve independently of each other inside a containing cylinder, the material to be crushed being fed into the cylinder, and being subject to the crushing action of the balls, the material being caught, sometimes between a ball and a portion of the cylinder, or some attachment to it, and sometimes between two or more of the balls themselves.

The method of separating the powder from the remainder of the substance, and of delivering it from the pulverising mill, also varies. Up till recently the usual method was to interpose screens of different fineness, with different numbers of perforations to the square inch, in the path of the crushed material, the coarser screens receiving the substance first, and handing back that which would not pass through their perforations to the crushers; the substance being subject to continuous crushing and continuous screening, until it was reduced to the required degree of fineness, when it was allowed to flow out of the mill.

It will be obvious that this screening method is open to certain objections, the principal of which is the tendency of the perforations to become larger with wear. Steam engineers know to their cost how any leak tends to increase, owing to the passage through the space forming the leak of the substance that is leaking through it. In the case of air leaks in the brickwork of boiler flues, the leak steadily increases with time, because the passage of the air through it rubs away a little of the brickwork, a little of the substance of the bricks for every cubic foot of air passing through it, and similarly when steam leaks from a pipe, or any other container. It will easily be understood that with such very fine holes as are necessary in the screens for powdered coal, and for the "gangue" of gold mines, there will be considerably more friction between the minute particles of the powder and the sides of the holes they pass through, than between the particles of air or steam and the sides of the leaks they pass through. The result is necessarily to increase the size of the holes, to throw two or more holes into one, and to lower the efficiency of the screen. With the gangue of gold and tin mines this is an inconvenience and a loss, but though the value of powdered coal is so much less than that of the few dwts. of gold recovered, the effect of increasing the size of the holes in the screen is far more serious, it means that the less efficient screen will allow powdered fuel to pass through it that cannot be so well burnt in the boiler furnace.

In the latest form of pulverising mill on the market, the powder is separated by means of an apparatus in which air does the whole work. This again is a development of other apparatus that have been on the market for a long time past in flour mills, and in other industries, in which powders of different substances are separated from each other partly by centrifugal action and partly by the aid of an air current. The air separator, or, as the makers term it, the vacuum separator, though only a low vacuum is maintained, is a conical-shaped vessel in which vertical dipper plates are fixed, whose angle with the axis of the apparatus can be arranged at will from outside; the point of the cone, or rather the frustrum, is fixed just above the pulveriser, and the upper portion of the vessel is connected to a pipe leading to an exhaust fan. Inside of the separator are other baffle plates arranged with the vertical dipper plates to direct the course of the air current that is carrying the powdered fuel. In operation, the fuel that has been reduced to the required degree of fineness passes into the exhaust pipe above, and thence through the fan to a collector, the material which has not reached the required degree of fineness falling down again into the pulverising machine, and being subjected to further crushing. The important feature of the separator and of the whole system is, it is maintained at a pressure slightly below that of the atmosphere, so that there can be no tendency for the fine coal dust to come out into the building. It is recognised by the inventor and the makers of the apparatus, that serious results might follow the egress of any appreciable quantity of the fine coal dust into the outer atmosphere, in case of a mixture of the coal dust and air meeting with a naked light, or a source of heat at a sufficiently high temperature to ignite the coal dust, an explosion might follow, similar to those that have occurred in coal mines, in oil seed mills, and in other places where carbonaceous dust is present in the atmosphere.

It will be understood that the whole process of burning powdered fuel in boiler furnaces is based upon the principles underlying the cause of the explosions that have been referred to. In those explosions a cloud of carbonaceous dust and air has been raised by various means; in the case of coal mines, usually by a blown out shot, though a case was reported some years ago of a small explosion in a mine roadway, due to a cloud of dust raised by a runaway train of mine wagons, and a piece of burning oily waste falling on the floor. The *modus operandi* is always the same; a small portion of the carbonaceous matter is burnt, due to ignition by a source of heat; in burning it liberates sufficient heat to raise the temperature of other portions of the combustible matter in its immediate neighbourhood to ignition point, those portions are burnt, more heat is liberated, more carbonaceous matter is rendered easily combustible, and the whole process goes on at a rapidly increasing rate, with the result that a large quantity of heat is liberated in a very small time, and in a small space; the heat tries to increase the volume of the products of combustion, also in a very short time, an enormous expansive force following and what we call an explosion. At one instant the air and the carbonaceous matter occupy a certain small space, at the next instant they try to occupy a space very many times as great, and when they are unable to do so, they often wreck the objects in their way.

In the boiler furnace, as we know, we do not want an explosion; we do want continuous combustion of carbonaceous matter, liberating quantities of heat in regular order, the heat so liberated being passed on to the metal heating surfaces, on the other side of which the water or steam that is to receive the heat lies, but the process is the same, except that no explosion should take place. When the furnace is started up, a small quantity of the coal dust should be ignited in any convenient way, the heat liberated by its combustion should raise

the temperature of dust in its neighbourhood to ignition point; this should be burnt, the heat so liberated causing the powdered fuel that is being fed through the burner to be burnt, its carbon to combine with the oxygen of the air that is supplied to the burner with the fuel, the continuous combustion of a continuous stream of powdered fuel being maintained. As will be explained later, for economic generation of steam, we want something more; we want the quantity of heat liberated by the burning fuel to be exactly in proportion to that required by the boiler, to that called for by the load upon the steam engine or turbine.

There is an important point that should be mentioned here: It will be remembered that in coal mines the presence of a very small quantity of carburetted hydrogen gas in the coal dust adds very considerably to the danger of explosion. It has been shown by experiment that while it requires 5 per cent and upwards of methane to form an explosive mixture with ordinary atmospheric air, if half per cent is present with coal dust the cloud formed by the coal dust is very much more easily ignited than without the gas, while, of course, a mixture of air and gas with only half per cent of air is perfectly harmless, perfectly non-explosive.

The makers of the apparatus for using powdered coal, therefore, as the writer understands, prefer bituminous coal, in which a certain percentage of volatile gas is present.

(To be continued.)

THE SOCIETY OF TECHNICAL ENGINEERS.

On Friday, the 19th December, 1919, Mr. E. Murray-Wrong addressed in Manchester a mass meeting of the Society of Technical Engineers on the subject "The Value and Purpose of Organisation."

He had not, he said, any special knowledge of the specific purpose for which the Society was formed, and it might be considered presumptuous for an outsider to attempt to address a body of men upon their own affairs. But it was not altogether out of place for people to give their views upon social movements in which they were not actually involved, for an outsider was in perhaps a better position to get such movements into proper focus.

He then went on to discuss the subject of trade unions and similar organisations, pointing out their comparatively recent inception, rapid growth and the various purposes they served or were intended to serve. It was more generally recognised, in contradiction to some earlier social doctrines, that organisation did not restrict individual liberty, but rather enlarged it, and nowadays it was becoming more and more difficult for the individual to express himself and his ideals, except through the medium of an organisation of some sort.

He welcomed the spread of trade unions into those classes in society which had hitherto remained aloof from the movement. He acknowledged that there was much prejudice against the formation of trade unions among those who represent the management of affairs, but the prejudice was rapidly dying out and numerous bodies of this nature are now coming into being. This prejudice was due partly to class traditions and partly to a genuine fear that trade unionism necessarily involved striking. This fear was due to an ignorance of the function of trade unions, which was more to negotiate than to strike—they were organisations for peace and not for war, although they had to be prepared for war in case of extremity. He thought that such an organisation as the Society of Technical Engineers might conceivably lend aid to the peaceful settlement of industrial disputes.

He recognised the difficulties which would confront the Society. It would be impossible to hold aloof from disputes between Capital and Labour, for at one end the Society graded almost imperceptibly into Labour, and at the other end into Capital. It would therefore be called upon to arrive at a more definite policy which would govern its attitude towards the two parties.

There might be some tendency towards an attempt to use the strength of the Society as a "Balance of Power" between Capital and Labour. This is condemned as a purely opportunist policy and one almost inevitably doomed to failure. An association, in order to succeed, must give its members something more than a material interest; it must diffuse the feeling that they are in some way assisting the community.

The Society might tend to become the appenage of Capital, which again he deprecated, as such an event would permanently alienate Labour and limit the Society's sphere of action.

In his opinion, the best course to pursue would be for the Society to associate itself with the Labour movement generally and send representatives to the Trade Union Congress and other Labour meetings. This proposal might sound alarming to many, but such policy would secure to the Society the advantage of a public hearing and the possibility of influencing public opinion, which is the main purpose of a political and industrial organisation.

Above all, it was important that the Society should develop the habit of straight and clear thinking upon the problems which were at the root of the present-day industrial revolution, for in a peaceful revolution of this nature, the body that was able to think most clearly and correctly was, in the end, most likely to be successful.

The address was followed by a discussion, in which a number of members took part.

JAPAN IMPORTING MACHINERY.

Machinery forms a feature, along with raw cotton and rice, in the import trade of the year which is increasing ahead of the export business. The large increase registered by machinery represents practically, along with that in the other two articles, the excess of imports on exports as registered so far.

This indicates partly the fact that speculative promotion is going on actively and partly the more complete release of trade from the yoke of war. The total value of machinery imported up to August is 60,935,495 yen against 36,883,811 yen for the same period last year, thus presenting such an increase as 24,051,684 yen. The shares taken by the different countries involved in this greatly-increased business

are given by the official trade returns up to July as below:—

Imported from	Jan. to July, 1919. Yen.	Jan. to July, 1918. Yen.
England	9,770,979	5,984,135
France	520,005	15,464
Switzerland	848,614	33,710
Germany	5,492	37,260
Sweden	2,128,049	292,116
America	38,922,000	23,344,084
Other Countries ..	85,547	464,607

Apparently the increase registered in the imports from Sweden represents the greater and freer importation of paper and pulp manufacturing machinery. The greater part of increase in the imports from England is, on the other hand, represented by spinning mill equipment. The imports from America cover larger and wider fields.

Spinning machinery imported up to July are valued at 6,998,475 yen against 3,625,333 yen for the same time last year, and 2,646,551 yen for the same time 1917. In some degree this increase may represent the increase in the price, but the quantity is also bigger, according to the official trade returns. This year's imports amounted to 12,068,342 kin against 8,863,63. kin for the same time last year, and 8,179,326 kin for the same time, 1917. Spinning and yarn twisting spindles were imported up to the value of 10,603 yen against 61,023 yen for the same time last year. In the import of card-clothing there has been a markedly greater increase. The total value to July reached 1,112,044 yen against 766,743 yen for the same time last year, and 293,987 yen for the same time, 1917.

Weaving looms are now being turned out in Japan on a large scale, and on the export list they, coupled with spinning mill equipments, form a rather prominent item, but a fair increase is still registered in imports. Up to July, these reached 998,518 yen against 437,966 yen for the same time las year. Tissue mercerising machinery have also increased from 15,778 yen for the first seven months of last year to 184,332 yen.

On account of the decline in the export business in cotton knit goods the importation of knitting machines was depressed last year, but this year it is improving. The value of imports up to July is placed by the official trade returns at 390,601 yen against 49,068 yen for last year.

Paper making machinery have witnessed a marked increase and form a feature in the year's machinery trade. According to the official trade returns the imports up to July were 1,801,607 yen which was an increase of 1,237,812 yen on the same time last year. The imports of felts up to July was 2,022,453 yen, which figure was an increase of 447,415 yen on the same time last year. Further, compared with the same time, 1917, the present figre is an increase of 1,685,419 yen. The import of metal nets has, on the other hand, remained almost unchanged, owing apparently to the increasing production at home. The import up to July is 328,934 yen against 344,700 yen for the same time last year.

Although steam boilers have increased somewhat, fuel economisers, tenders, locomotives and such articles have not been much in evidence in the machinery trade. Water turbines and penton wheels have, on the other hand, increased pretty largely. The total value up to July was 1,025,572 yen, which was an increase of 1,005,081 yen on last year and of 891,857 yen on the same time, 1917. Dynamos, electric motors, transformers and others have also registered a featuring increase up to 2,934,661 yen against 1,472,502 yen for the same time last year.

Metal and wood working machinery has, however, recorded a gain of greater importance. Up to July the imports reached 6,761,676 yen against 3,625,333 yen for the same time last year and 1,657,790 yen for the same time in 1917.—*Yokohama Chamber of Commerce Journal.*

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

Altrincham Branch.

The first lecture of the season took place on January 16th, at the Liberal Rooms, Kingsway, Altrincham, and was delivered by Mr. Gerard, the subject being "Foundry Practice." The paper was most instructive and interesting, and some very clear diagrams were shown, most of them being drawn in isometrie.

CLASSES OF MOULDING.

Mr. Gerard (who is a practical foreman moulder of long experience) commenced by describing fully the three classes of moulding, viz., green sand, dry sand, and loam, the latter of which he has devoted much time to.

DRYING MOULDS.

The various methods adopted in drying moulds for dry sand casting were fully dealt with, and the importance of providing efficient vents, etc. A full description, with diagrams, was given for the moulding of a large 20-ton engine-bed. Loam moulding was then fully described, and an example was given, this being a large surface condenser body. The complete building up of the mould, details of the core, and improved types of arms, etc., was carefully outlined by Mr. Gerard, and many valuable hints, etc., were given.

Owing to the length of the paper, there was only time for a short discussion, after which the lecturer was heartily thanked for his most interesting paper.

Young Engineers: Scholarships for Promising Apprentices.—Engineering scholarships, tenable at the Manchester Municipal College of Technology, or some other suitable institution, are to be founded in Manchester as a result of the generosity of the contractors to the Manchester and District Armaments Output Committee. After the activities of this committee ceased certain funds remained in their hands, which it is intended to apply to the object named. The following gentlemen comprise the Board of Governors, of which Mr. H. Mensforth has been elected chairman: Mr. R. E. Hattersley, Mr. J. Hoyle Smith, and Mr. E. D. Simon, M.A., representing the contractors to the Manchester and District Armaments Output Committee; Mr. A. P. M. Fleming, M.Sc.Tech., manager, Research and Education Department, Metropolitan-Vickers Electric Co. Ltd.; Mr. H. Pearce, Director Manchester District Engineering Trades Employers' Association; Mr. T. I. Holt, Amalgamated Society of Engineers, representing Labour; Mr. H. Mensforth, C.B.T., M.Sc.Tech., Mr. John Taylor, O.B.E., and Mr. J. Bissett, O.B.E., representing the Manchester and District Armaments Output Committee. The scholarships are primarily intended for boys of British birth, whose exceptional ability and promise have manifested themselves during their apprenticeship in works in the area which was covered by the activities of the Armaments Output Committee. Five scholarships will be awarded each year, for a period of ten years. At the end of this period it is expected the fund will be exhausted, but it is hoped that it will be possible to continue the scholarships by the further generosity of the engineering firms in the area.

Notices will be posted in the different workshops in the area bringing the attention of the boys to the scheme, and any further information can be obtained from Mr. H. J. Brocklehurst, M. Eng., hon. secretary, c/o The School of Technology, Manchester.—*Daily Dispatch*, January 26th.

Trade Items, Notes, &c.

COAL MINING FATALITIES IN THE UNITED STATES.—That coal mining is one of the most important industries of this country has been brought home to every citizen during the past few years. The amount of coal produced now approaches closely to 700,000,000 tons years, employing about 760,000 men. That it is a laborious and dangerous occupation is well established by the statistics of death and injury published from time to time. A bulletin prepared by A. H. Fay, has just been issued by the Bureau of Mines, giving the fatalities in the coal mines of the United States during 1918. This was a year of somewhat abnormal conditions. The demand for coal was much increased over that of previous years, many of the expert miners and supervisors had enlisted or entered into more profitable industries, and a not inconsiderable number were drafted. This naturally made for a greater proportion of accidents, as many comparatively inexpert men were employed, but, on the other hand, the more continuous operation of the mines prevented accumulation of gases, and in some other ways improved conditions as compared with mines operated only part time. The total fatalities reported, including all fuel mining during the year, was 2,579. The non-fatal injuries are not given in the bulletin, but taking Pennsylvania statistics as a guide, it may be estimated that these amount to at least three times the fatal accidents, so that the total for the United States will be about ten thousand casualties for the year. There is still to be counted as part of the perils of the industry the disease and debilitation produced, especially the liability to tuberculosis, and in some mines to hook-worm. No data on these points are at hand, and no estimate can be made, but there is little doubt that the morbidity percentage will be fairly high. Pennsylvania being the only State in which any considerable anthracite mining is carried on, it is interesting to note that in 1916 the fatalities and non-fatal accidents in that industry were much higher than in the bituminous mines of the State. The figures show that one life was lost for 155,000 tons of anthracite mined, and one life for 388,000 tons of bituminous coal. The non-fatal accidents were also of higher ratio in the hard coal mines. Part of this difference may be due to the depth at which anthracite is now generally mined. In Pennsylvania in 1916 the fatalities left 631 widows and 1,510 orphans. Taking the United States at large for 1918 the production of coal of all kinds per life lost was 266,000 tons, an improvement over 1917, in which the production per fatality was 241,000 tons. The days worked in 1917 were 251, and somewhat higher in 1918.—*Franklin Institute Journal.*

CHANGES PRODUCED IN GAS BY-PRODUCTS BY VARYING TEMPERATURES.—Dr. E. W. Smith, Chief Chemist of the City of Birmingham Gas Department, in the course of a recent lecture on the "By-Products of Coal Gas Manufacture," dealt with the interesting question of the varing effects produced by different temperatures as applied to the distillation of coal. He said that when bituminous coal was heated in a retort the substances composing it changed in a very mysterious way and in an extraordinary number of ways, depending entirely on the amount of heat developed. If coal were heated up to one temperature, the volatile matter that ultimately cooled down might consist of a considerable amount of petrol, but if the very same process were carried out at a much higher temperature, the resulting product might be benzole and there might not be a trace of petrol. The truth was that practically every one of the constituents of coal changed considerably in composition at higher temperatures. Thus it was found that the conditions under which the coal was heated and the volatile matters were driven off at high temperatures, controlled entirely the question of what products were obtained ultimately.

THE ENGINEERING WORKSHOP HANDBOOK. By ERNEST PULL, A.M.I.Mech.E., M.I.M.E. London: Crosby, Lockwood and Son, Stationers' Hall Court, Ludgate Hill. 3s. net.

This little book, although serving quite a useful purpose at the present time, is a little late to secure full appreciation of its merits. We note that it is a revised and enlarged edition of "The Munition Workers' Handbook," and no doubt that earlier work was largely bought by those persons who entered an engineering shop for the first time when war was abroad. The book is handy in size and is pack full of useful practical information. The matter is clearly put, and there is an absence of verbiage—a most necessary qualification for a *vade mecum*, which is to be carried about in one's pocket and produced when occasion demands.

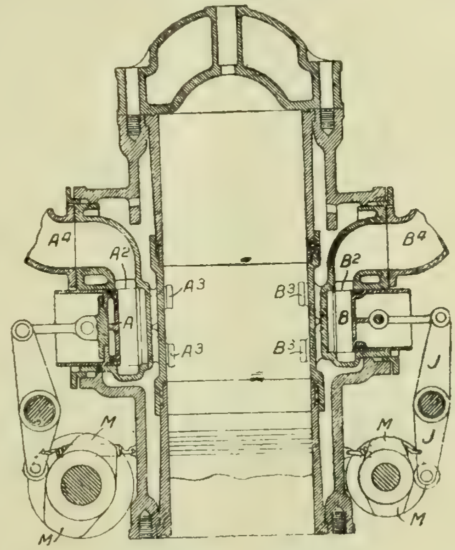
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

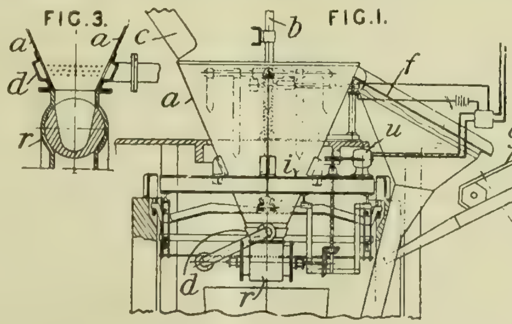
124,396.—NORTH BRITISH DIESEL ENGINE WORKS, LTD., South Street, Whiteinch, and J. C. M. MACLAGAN, 14, Park Corner, Westland Drive, both in Glasgow.—Nov. 7th, 1918.—In a two-stroke-cycle double-acting engine, exhaust ports A3 are controlled by a



piston valve A, and scavenging inlet ports B3 by a similar valve B. The valves are arranged co-axially on opposite sides of the cylinder and are actuated by cams M and rocking-levers J. Exhaust and supply passages A4, B4 communicate with the cylinder ports through annular ports A2, B2 respectively.

WASHING COAL, ETC.

125,781.—W. R. STOBART, Etherley Lodge, Bishop Auckland, Durham.—April 30th, 1918.—In an apparatus for washing coal and the like, which may be an upward-current classifier of the type described in Specification 6789/84, the washer is mounted on a weigh-bridge, the tipping of which due to the accumulation of heavy refuse, is utilised to operate the discharging-means or to indicate when such operation is necessary. The washing hopper *a*, to which water is admitted at *d* and coal at *c*, is mounted on a weigh bridge *i*, the agitators *b* being independently supported.

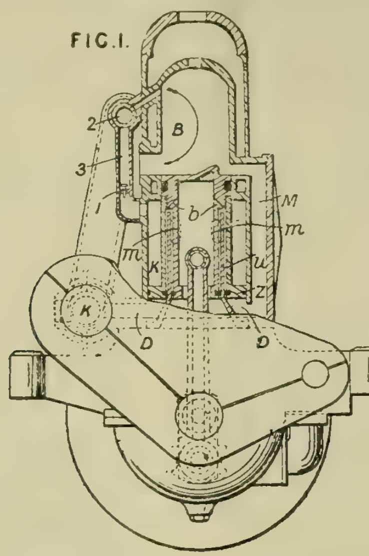


The washed coal overflows with the water and passes over a perforated plate *f* to a conveyor *g*. When the weigh-bridge falls, the discharger *r*, which may be o the form shown in Fig. 3, may be operated manually or by an electric motor *u* controlled manually or automatically. After the discharge has been effected, the apparatus rises and remains in that position until there is again a sufficient accumulation of heavy refuse. When the motor *u* is automatically controlled, means may be provided for keeping the motor circuit closed until the discharger has completed its movement, irrespective of possible vibration of the weigh-bridge. In some cases, the discharger may be driven continuously, the speed of the motor being varied automatically by means of resistances controlled by the tipping of the weigh-bridge through a dash-pot device.

INTERNAL-COMBUSTION ENGINES.

125,789.—J. R. DE ABURTO, 58, Zurbano, Madrid.—May 6th, 1918.—An engine with a cylinder and pump in line has a piston of two diameters which compresses, with its annular portion Z, combustible mixture on the bottom side and air for scavenging and cooling the interior of the piston with its top side. The

FIG. I.

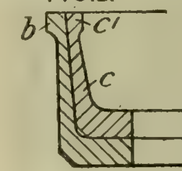


combustible mixture enters the pump space through a non-return valve (not shown) and is transferred to the combustion space B through a passage M. The air charges are admitted to the pump through a passage D controlled by a rotary valve K and are delivered, for scavenging the cylinder B, through a passage 3 containing a non-return valve 1 and, at its discharge orifice, a rotary valve 2. The piston reciprocates over a cylindrical guide u and has formed in its walls a series of ports m, b through which cooling-air is circulated during the up-stroke of the piston.

VALVES.

125,990.—L. LEON-BILLANT, 33, Rue Robillot, Paris.—April 23rd, 1919.—A stop valve is actuated by a differential-screw mechanism. The valve member 12 is formed on the end of a spindle 11, prevented from rotating by a pin 16 engaging a slot 15 and provided with a threaded portion adapted to engage internal threads on

FIG. 2.

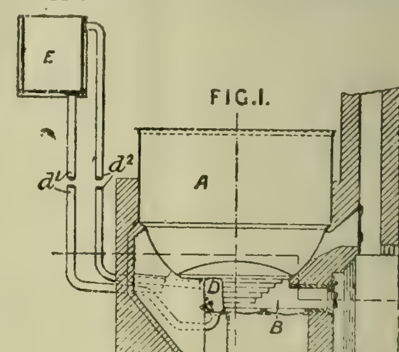


an externally screwed actuating-spindle 8. The actuating-handle is graduated and works in conjunction with a fixed pointer carried by a cap adapted to compress a packing 6.

FURNACES.

125,894.—C. H. MARTIN, Denysfield, Warren Road, Blundellsands, near Liverpool, and H. S. Fox, Wenlock Road, City Road, London.—Nov. 14th, 1918.—In industrial installations having furnaces, and in which a supply of hot water is required for subsidiary

FIG. I.



purposes, the central portion of the fire-bridge is formed as a water chamber connected by circulating pipes to a storage tank. As shown, a brewing copper A is heated by a furnace B having a fire-bridge of which the central portion is a steel or cast-iron water chamber D connected by pipes $d1$, $d2$ to a storage tank E. The chamber D may be of T shape in plan, the long leg of the T forming part of a partition between two semi-annular flues leading to the chimney.

INDEX TO ADVERTISERS.

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— THE —

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EDITORIAL.

AIDS TO TRADE EXPANSION.

TO-DAY'S activity in aiding the expansion of our foreign trade—the reorganisation in our Consular machinery—the dissemination of information through the trade press and the general tremendous effort to advance our goods throughout the world is most excellent. The one regret is that it should have taken a world-war to bring this change about. Surely one of the brightest auguries for the future is the present constitution of the Parliament. There is an increasing number of business men undertaking national duties—men who have made good in competitive business, and who, we feel sure, will not either see eye to eye or will stand for the methods of the lawyer politicians.

So we have a practical Overseas Trade Department with a competent organisation and a practical policy. One outcome of the new régime are the Industrial Fairs which are held annually. On February 23rd three such Fairs will be held at London, Birmingham, and Glasgow respectively. Undoubtedly, exhibitions of this character are of immense value. They are practical, contain nothing in the way of entertainment, and are run on purely business lines. Hitherto we had in the main to depend upon those big unwieldy shows that included in their make-up water-chutes, switchbacks, and the latest type of thrilling hair-raising stunt. Some of these exhibitions contained enough manufactured goods to act as a peg on which to hang a high-sounding name, and only just enough. Others, it must be confessed—such as the Franco-British—were excellent in many directions, but perhaps one visitor in a thousand was interested in the manufactures—and that is a generous proportion. At the Industrial Fairs 100 per cent are directly interested.

Recently we have received details of the proposed Trade Tours. These tours are designed to be a cheap and comprehensive vehicle for the display of home products. Samples will be packed and carried in specially-designed show-cases and exhibitions erected in various cities throughout the world. The cost is comparatively cheap, and, provided adequate and suitable arrangements can be made, the return should be considerable. This is work that is of the highest value to us in our present state, as it is only by increased production and larger exports that we can bring our financial affairs back to the normal.

Cinematography is going to play a very big part in the trade development of the future. There are great possibilities in its use, and many firms have already recognised the fact. No doubt our earlier efforts will be crude, but just as the film business has developed and produced men who know what is striking and effective, so shall we eventually find men who can pick out the essentials and present the most telling details in an entertaining but forcible and instructive manner.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 168.*)

We are now in position to determine the values of the constants C_1 and C_2 for the equations for point No. 10, and on referring to equations (50) and (51) it will be seen that we need the values of

$$\frac{(a+b)^{\frac{1}{2}}(c+d)^3}{4(d-b)^{\frac{5}{2}}}$$

and

$$\frac{(a+b)^{\frac{1}{2}}(c+d)^3}{4(d-b)^{\frac{3}{2}}}$$

which will be found to be 26.14 and 78.41 respectively.

Now referring to equation (52) and using the above values, we have:

$$49 = 26{\cdot}14 \left\{ (4+0-3)({\cdot}484 + {\cdot}912) + 2 \times 3 \times {\cdot}484 \times {\cdot}375 \right\} + C_1$$

from which:

$$C_2 = 130$$

Next referring to equation (53) and using the above values, we have:

$$162 = -78{\cdot}41 \left\{ (4 \times 0 - 3)({\cdot}912 \times 1{\cdot}667 + 1{\cdot}291 - {\cdot}912) + 2 \times 3({\cdot}912 - {\cdot}484) \right\} - 130 \times 3 \times 1{\cdot}667 + C_2$$

from which:

$$C_2 = 567$$

Having now determined the values of the C_1 and C_2 for use in equations (52) and (53) for the short (No. 1) plate, we need, for present purposes, simply to use equation (51a) and note that:

$$y_1 = \frac{567\ W_1}{EI_0}$$

For many cases, especially when the plates are of the same section, as is assumed to be the case in this example, it is convenient to discard the constant factor $1/EI_0$ in the intermediate operations, and we may write:

$$y_1 = 567\ W_1 \text{ or } A_1 = 567$$

The discarded factor can be reintroduced at any time when found necessary and, in general, it will be found conducive to accuracy to omit it until it is required for final calculation. Of course, in any case where the cross section of the plate above is different from that of the plate below, it is necessary to introduce either the actual values of the factor or else the ratios of the two I's, the handling of which ratio will often be found to be the best method of procedure in practice, reserving the introduction of the value of E and I_0 until the final deflection relation is required.

We may here note that if there were no taper on this plate, so that it had the (No. 1) square point, the corresponding value of the deflection coefficient would be $11^3/3 = 443$, so that the taper has the effect of adding nearly 30 per cent to the flexibility in this case.

The calculations for this example have been worked out mostly on a 10-in. slide rule, so that it is possible—and even likely—that there are small errors, but these will not be sufficient to affect the general accuracy of the comparisons. For actual work in the spring designing room, where greater accuracy is desired, it is better to work out the results to not less than four, and preferably to five figures by the aid of a calculating machine; for present needs this did not seem to us to be necessary, as the results are rather intended to indicate methods and offer general comparisons than to give examples of actual designs.

We now pass on to the calculations for the second plate.

Second, for Plate No. 2 and for the Reaction W_1 Acting at the Distance $l_1 = 11$ in.

On referring to Fig. 27 it will be seen that for this section of the calculations, we have $l_1 = 11$, $a = 2$, $b - 3$, $c = 3$ and $d = 6$, while the double taper commences at $x = 9$.

Making use of the above values, we find that:

equation (43) gives $C_1 = 2$, and

equation (44) gives $C_2 = 2095$

then for the point $x = 9$, where the double taper commences,

$$\text{equation (41) gives } \frac{EI}{W}\frac{dy}{dx} = 59, \text{ and}$$

$$\text{equation (42) gives } \frac{EI}{W}\ y = 324.$$

It will be seen that the angular functions are the same in this as in the first section of the calculations, and the application of equation (52) and the above figures show that the value of C_1 to be used in equations (52) and (53) is -217. Similarly, it will be found that the value of C_2 to be used in equation (53) is 535.

Having now found the values of the two constants C_1 and C_2 of integration for equations (52) and (53), we are in a position to calculate the values of dy/dx and y for plate No. 2 at the point $x = l_1 = 11$.

Using the reduced expression for the angular function, it will be found that:

$$\sin^2\theta = \cos^2\theta = \sin\theta\cos\theta = .500$$

$$\tan^2\theta = \tan\theta = 1$$

$$\theta = 45^\circ = .785 \text{ radians.}$$

Making use of these values, equation (52) shows that for $x = 11$ $dy/dx = 63W_1$, omitting the factor $1/EI$ as mentioned before, and equation (53) shows that $y_1 = 447W_1$.

The deflection at the end of plate No. 2, due to the reaction W_1 acting at the distance l_1 is, evidently, making use of the above figures, equal to $(447 + 63 \times 3)\ W_1 = 636W_1$.

Third, for Plate No. 2 and for the Load W_2 actin at the Distance $l_2 = 14$ in.

For this section of the calculations it will be seen that $l_2 = 14$, $a = 5$, $b = 0$, $c = 6$, $d = 3$ and the double taper commences at $x = 9$. Using these values we find that:

equation (43) gives $C_1 = 10.5$

equation (44) gives $C_2 = 1986$

then for the point $x = 9$, where the double taper commences,

$$\text{equation (41) gives } \frac{EI}{W}\frac{dy}{dx} = 84, \text{ and}$$

$$\text{equation (42) gives } \frac{EI}{W}\ y = 447$$

The circular functions are the same as for the first section of the calculations, so that equation (52) gives $C_1 = 165$ and equation (53) then gives $C_2 = 1007$.

An examination of the foregoing figures will show that:

$$A_1 = 567 ; \ A_2 = 0 ; \ A_3 = 447 ; \ A_4 = 636 ; \ A_5 = 1007 ; \ A_6 = 636,$$

it being of course understood that the factor $1/EI$ has been omitted.

Now proceeding in the same manner as for the previous examples, we find that $B_1 = A_1 = 567$, $C_1 = .6282$, $B_2 = 607$, and for $W_1 = 1.000$ we have $W_2 = 1/.6282 = 1.592$.

Let us now suppose that the plates of the spring are 3 in. wide and $\frac{3}{8}$ in. thick, with $I = .01318$ and $Z = .07032$, and allow a maximum stress in the bottom or No. 1 plate of 100,000 lbs. per square inch. We will take E as equal to 28×10^6.

For this stiffness of the spring, we have $EI/B_2 = 28 \times 10^6 \times .01318/607 = 610$ lbs. load per inch deflection. The safe load on the bottom plate will be $100000 \times .07032/11 = 639$ lbs. and the corresponding load at the end of plate No. 2 will be $639 \times 1.592 = 1017$ lbs.

It is now easy to calculate the stresses in every part of each leaf of the spring; this has been done, and the results are as shown in Fig. 28. It will be seen that the maximum stress in the tapered portion of plate No. 1 is almost exactly the same as the

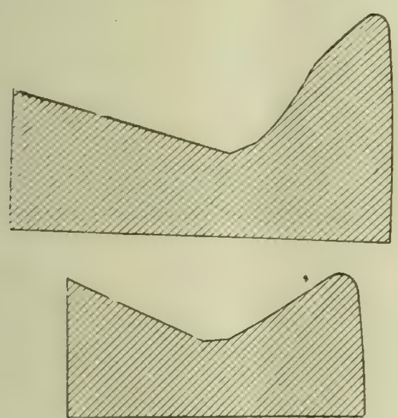

Plate Springs.—Fig. 28.

maximum stress at the central point of encastrément being, in fact, 103,000 against 100,000 lbs. per square inch. For the longer or No. 2 plate it will be noticed that the maximum stress in the tapered portion is considerably greater, being 164,000 lbs. per square inch, which of course is considerably too high. This indicates that the taper of the No. 2 plate is too fine, and that the point should be made somewhat different in design, which should be of such proportions as to bring the stress in the tapered portion down to about the same value as that in the body of the plate. The stress at the central point of encastrément is just about the same as for the No. 1 plate, being 102,000 lbs. per square inch, so that, except for the somewhat fine taper at the end of the No. 2 plate, this two-plate spring may then indeed be said to be of economical proportions, with fairly uniform stresses all over.

An examination of Fig. 28 shows that near the ending of the uniform section of the plates, and at the commencement of the tapers, the stresses are considerably lower than either in the body of the plates or in the tapered portions. This shows that it would be an advantage to remove some of the metal in these portions of the plates—for it is always better to keep the stresses everywhere as uniform as

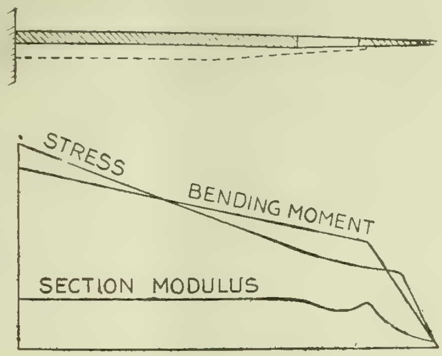

Plate Springs.—Fig. 29.

possible, so as to utilise the metal to the greatest possible advantage—and it has been found that by punching suitably shaped and properly placed holes in the position mentioned, the stresses are equalised to a great extent and the endurance of springs is increased: this has been thoroughly verified by many tests on the endurance machine, and also by regular use of such springs on the road. These holes or slots are termed "stress equalising slots" and form part of U.S. Patent No. 13,199,013, September 19th, 1916. The effect is shown in diagrammatic form in Fig. 29, which figure is copied from that of the patent specifications.

As has already been stated, in most actual springs the plates separate on the application of the load, except at the ends and at the centre point of encastrément. This may be verified by calculating the deflection of the plates at intermediate points by the use of the proper equations and noting the differences of such deflections, of any two consecutive plates. The actual amount of separation is very small, to be sure, so that very accurate calculations are necessary in order to obtain concordant results.

With the very flexible tapers which are sometimes used on the ends of the leaves, cases occur where the leaves tend to foul into one another. The effect of this is that instead of the leaves touching at the ends only, they have a contact for a distance depending on the flexibility of the tapered end. The only way to determine this is to calculate the deflections of the leaves at several points and compare the results. When this fouling tends to occur it shows that the tapers are too fine, and instead of the reactions being at the tips of the leaves they shift nearer to the centre of the spring, so that too fine a taper is equivalent to shortening the leaf. The calculations involving such "fine" tapers are complex, and seldom of commercial importance.

(To be continued.)

OPENING FOR GOODS IN LITHUANIA.

Lithuania will be a very good market in the near future. There is already a very good demand for soaps, glues, paints, varnishes, dyes, chemicals, agricultural machinery, machine tools, motor cars, tractors, locomotives, motor cycles, steam boats, electric light plant, fuel, essences, petroleum, furniture, clothing, hats and caps, building materials and foodstuffs in general.

GRINDING WHEELS FOR AUGERS OR BITS.

By P. N. Cooke.

In the manufacture of augers or bits, grinding plays an important part in bringing about production, accuracy, and economy. From the time these tools leave the drop forge and the heat-treating room, the grinding wheel or set-up polishing wheel is depended upon to produce the finished product for the market.

Directly after forging the grinding wheel is introduced. The operations are rather severe and call for wheels of hard grade. On the particular type of

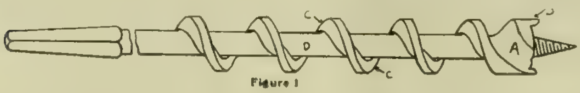

Figure 1

bit illustrated in Fig. 1 there are three principal operations involved, employing the solid grinding wheel.

"A" represents the cutting surface of the bit after the screw has sunk deep enough to permit the lips "B" to bite the stock. The die used in the drop forge is designed to leave considerable metal in this part of the bit, in order that the wheel may leave a sharply defined groove and cutting edge. The wheel for this work should be applied while the steel is soft, having first been annealed after forging.

An alundum rubber wheel in 36 or 46 grain, made in varying thicknesses to care for different sized bits, has been found very well adapted for this operation. With this wheel the excess stock is readily removed with one cut, the wheel being the exact width of the groove and the face formed to a templet to give the required shape. Occasionally, dressing will be necessary to retain this shaped face.

After this initial grinding process, the bit is hardened and tempered. On account of the heating and sudden cooling from these processes, there usually occurs slight warping. This condition is remedied by succeeding grinding operations. Offhand grinding of the "twist" is accomplished by the use of a rubber wheel of grain size 60 or 70. The surface ground is represented by "C" in the first illustration. By selecting a wheel of the proper thickness to accommodate the size of bit ground the experienced operator is able to produce a finished concaved surface, extending from the periphery of the bit to the web, without leaving any shoulder at the centre. The bit is revolved by hand and held against the formed face of the wheel, at the same

Figure 2

time traversing to accommodate the "pitch of the helical flutes."

For a commercial finish to make the product marketable there remains to be ground the cylindrical portion of the web designated by the letter "D." This is accomplished by a cylindrical operation, the bit revolving on centres and traversed automatically by a wide alundum rubber wheel, the thickness being determined by the distance between the "twists." The specifications for this work favours the alundum rubber size 70 grain.

The 60 or 70 alundum rubber wheel is also used on a third type of bit not illustrated, but which is similar to Fig. 1 with the exception that the web is omitted and the "twists" are closer together. The foregoing describes somewhat in detail grinding methods which are followed in the manufacture of two very popular styles. There is another type, represented by Fig. 2, which requires a somewhat different procedure.

For the cylindrical grinding of this bit, it is sometimes the practice to utilise the sandstone. In a recent test of large alundum wheels 40 in. in diameter by 6 in. thickness, it was demonstrated that where a sandstone was entirely consumed the alundum wheel wore only a fraction of an inch on the diameter. This would favour its use, taking into account the difference in first cost.

Other problems met in grinding these tools will be found peculiar to each manufacturer. These can best be handled by considering each problem individually.

For producing the final polish, leather-covered wood wheels when properly mounted with TJ alundum grain in sizes from 70 to 90 will be found to give maximum satisfaction when cost and production are taken into consideration.

SUPERIOR WORK TOOLS MADE FROM ALUMINIUM OXIDE.

If aluminium oxide (Al_2O_3) be vitrified at a temperature below its temperature of fusion, a product of great density and hardness is obtained possessing properties peculiarly favourable to the manufacture of many tools. This process is now employed in the States for the production of "drawing stones" for the purpose of the finest metal wire drawing. Roughly-formed pieces of the material are first heated to from 1,300 to 1,400 deg. Cen., and are then shaped and reheated to 2,000 deg. Cen. The degree of hardness of this substance resembles that of sapphire, and it exhibits uncommonly little sign of wear and tear after use.

THE IRON INDUSTRY IN FRANCE.

We learn that in the Department of Meurthe-et-Moselle (an important industrial centre in the north-east of France) a number of blastfurnaces are again in full swing, and, namely, 10 at Nancy (out of a total of 27), three out of 18 in Briey, and three out of 33 at Longwy. Hence, out of a total of 78 blastfurnaces, 16 are once more active. It is expected that still others will shortly resume operations in this department, namely, one each at Joeul, Senelle, and Aubrives, and two at Chiers. Still more furnaces could resume work at once, if it were only possible to obtain the necessary regular supplies of coke. Reports regarding the French pig-iron market state a new syndicate for hematite pig iron recently commenced operations; it has so far been formed for a period of five years, with power of extension.

FUEL OIL IN SUMATRA.

In a general way there is no supply of fuel at Belawan, the port of Medan, available for purchase except on notice of at least two weeks. Under ordinary circumstances vessels can be furnished with oil sufficient to take them to Singapore, which would not require more than six tons. Probably 40 or 50 tons could be given any ship on due notice, and the only supplier of oil, a Dutch concern, would use every effort to supply oil-burning vessels calling at Belawan with a sufficient quantity to enable them to proceed either to Singapore or to Batavia. No oil tanks have been erected at Belawan, and oil would therefore be loaded from lighters. For the present, or until the harbour works can be completed, permitting deep sea vessels to enter the ports, no tanks will be constructed, and not even then unless probable business warrants it. It is impossible to give current prices, but it is not likely that these would be much in advance of those obtaining either at Singapore or at Batavia, and the excess, if any, would be due to the lack of proper installations for loading oil into ships.

EARTH CONNECTIONS.

By E. Austin.

A Matter of Importance.

The efficient earthing of all metal work associated with an electrical installation is a matter of great importance. The frames of electric motors, metal switch cases, conduits, and other metal parts that are liable to be made "alive" as the result of faulty insulation must be efficiently connected to earth, otherwise in the event of the insulation of the system failing, operators and others are liable to receive dangerous shocks. One of the rules in the Memorandum of the Electrical Inspector of Factories stipulates that, in order to prevent danger, the metal parts of an electrical installation that are liable to be electrically charged must be earthed. Earth connections are also needed for earthing the neutrals of transformers and generators.

Methods Adopted.

Often the earth conductor which couples all the metal parts of an electrical installation together and finally connects them all to earth is connected to a water main, but it may happen that a water main is not accessible or that the water company objects to it being employed. Water mains are nevertheless widely used as earth connections, and, as a rule, they serve the purpose quite well, provided, of course, that the connection between the earth conductor and water main is perfectly good. The earth conductor should be connected to a main pipe and not a branch pipe that is liable to be disconnected. Usually the connection between the pipe and conductor is made by means of an iron band capable of being tightly clamped to the pipe, which should naturally be well cleaned. The earth conductor should be bolted or otherwise firmly attached to the band. Gas mains should never be used as earth connections.

A Common Method.

A scheme often adopted is to bury a copper, cast iron or galvanised iron plate in moist earth, the plate being surrounded by a tightly-packed bed of broken coke charcoal or carbon. The condition of the ground with respect to moisture determines the depth at which plates should be buried, but as a rule a depth of about four or five feet measured between the surface and the top of the bed of coke is sufficient. These earth plates must be buried in a position where wet or dampness is always present; otherwise the resistance of the earth connection will be too high. It is better to use two earth plates than a single plate. Often the coke bed and surrounding ground are impregnated with a solution of rock salt which considerably reduces the resistance of the earth connection, but if the application of a salt solution be relied upon to maintain the earth resistance at a low value resistance tests should be made periodically in order to ascertain when the addition of salt is necessary.

Periodical Testing.

All earth connections ought, in fact, to be tested periodically and records should be kept of the resistances obtained. This is another reason why duplicate earth plates are desirable, for with two plates the measurement of the earth resistance presents no difficulty, and it is unnecessary to interfere with the earthing of the electrical installation whilst the resistance test is being made. Sometimes engineers adopt the plan of connecting the earth conductor to a buried plate and a water main as well, and there is no doubt that then, when the practice is permissible, it has much to recommend it. Opinions differ in respect to the correct dimensions for earth plates, but speaking generally, no plate should be less than 2 feet square, and for large electrical installations the plates may measure 5 feet by 3 feet or more. In any case, two earth plates are always preferable to a single plate unless the earth conductor is also connected to a water main. Two earth connections greatly minimise the chance of the system being imperfectly earthed and facilitate the testing of the earth plate resistance. Occasionally, each piece of apparatus to be earthed is connected to a separate plate, but the practice of earthing the whole system at a common point is now much more general. Subject to the Electricity Regulations compiled by the electrical inspector of factories, metallic conduits and cable sheathings can be used as earth conductors.

Other Methods.

The steel armouring of cables can be made to serve as earth conductors. Similarly, when wires are enclosed in steel tubing and the separate lengths are electrically continuous, earthing may be done by connecting the tubes to earth at several points, but this practice is only permissible when the joints are electrically sound. But if the various lengths of tubing are not screwed together or are not efficiently bonded, a separate earth conductor must be used. All joints must be perfectly clean, and if the continuity of the tubing is anywhere interrupted great care must be taken to well bond the tubes where the breaks occur. Under no consideration must metal tubing be made to serve as an earth conductor when the ends of the tubes simply slide into sockets, as owing to the imperfect contact afforded by such joints a good earth connection is not likely to be secured. In the event of the tubing becoming a conductor arcing is liable to occur at the joints.

The Use of Pipes.

Pipes driven into the ground can be used for earthing purposes and they have been largely employed abroad for lightning arresters for protecting transmission lines, etc. A low resistance earth connection suitable for earthing an electrical installation can be obtained by sinking a number of pipes and by connecting them in parallel. Experience shows that pipes driven into the ground to a depth sufficient to ensure that they are in contact with water, maintain an almost constant resistance, but, of course, difficulty may be experienced in putting this scheme into practice. It is more usual to drive pipes into the ground to a depth of about 5 or 10 feet. A depth greater than 10 feet does not, as a rule, reduce the contact resistance, unless the lower end of the pipe reaches water. In any case, the ground into which the pipe is driven should be maintained in a moist condition. Waste water may be discharged over earth connections with advantage, and it may be found necessary to treat the soil with rock salt. One method of treating these earth connections is to remove some of the earth away from the upper extremity and to surround this part of the pipe

with an earthenware drain pipe which is filled with rock salt. Of course, from time to time the salt must be renewed and it must be kept moist with water.

The Paragon Earth Cone.

A very efficient method of earthing is by means of the Paragon earth cone shown in the accompanying illustrations, Figs. 1 and 2. The cone is composed of a sheet of perforated copper bent to the proper shape and filled with charcoal. Moisture is absorbed by capillary attraction, and the earth around the cone is consequently maintained moist for long periods. The base and crown of the cone are connected together by a copper rod passing through the centre and having a screwed connector at the upper extremity to take the earth wire. The cone is made in two standard sizes, designated Nos. 1 and 2.

Fig. 1.—A Paragon Earthing Cone.

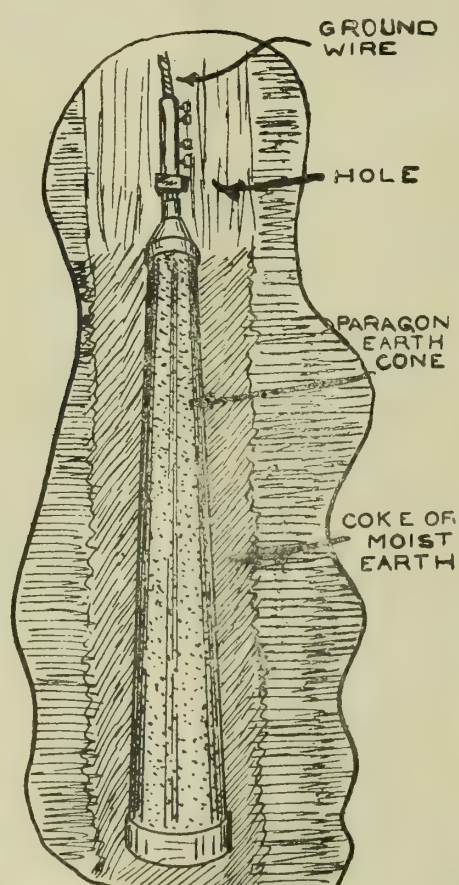

Fig. 2.—Details of the Paragon Earthing Cone Sunk in the Ground.

The former is 12 inches long and $2\frac{3}{4}$ inches in diameter at the base, whilst the No. 2 size cone is 2 feet long and 4 inches in diameter at the base. Of course, when the No. 2 size cone is not large enough to meet requirements, a group of cones may be buried in the earth and be connected in parallel. Earthing cones of this description can readily be installed. All that is necessary is to form a hole in the earth a little larger than the base of the cone. A suitable hole can readily be made by means of a post-hole auger. These earthing cones have been found suitable for most conditions met with in practice, but they are not recommended for use where there is a heavy and continuous leakage current, because in such cases the cones would eventually be destroyed by electrolytic action. Cones of this sort are, however, applicable in a great many cases. The geometrical form provides a good contact with the earth and the construction permits of heavy currents being carried on for short periods. A current of 400 ampères has been passed through one of these cones for a period of ten minutes without undue heating occurring. The normal current-carrying capacity of the No. 2 size cone is about 60 ampères, but, of course, any desired current capacity can be obtained by using a number of cones connected in parellel. The special feature of these cones is their ability to retain moisture and on this account they are claimed to be infinitely superior to earth plates. There are, of course, places where it is difficult to retain moisture in the vicinity of the earth connection, but experience has shown that even under the worse conditions these Paragon cones offer marked advantages.

It is claimed that these cones, which are supplied by Messrs. Scholey & Co. Ltd., of 56, Victoria Street, London, S.W.1, are suitable for electric light, power, telephone, telegraph and electric traction service. They are very suitable for earthing steel chimney stacks and lightning conductors of all resistances. wherever possible, the cones should be buried in rich black loam and never in clay soils if it can be avoided. Briefly, the main points demanding attention when installing these cones are:—(1) A spot should be selected where there is permanent moisture. (2) The hole should be bored deep enough to reach permanent moisture. (3) The same kind of earth should surround all parts of the cone and leading in wire. (4) The earth should be well forced round the cone and leading in wire, and (5) there must be no soldered connection in the leading in wire below the surface of the earth.

A NATIONAL POLICY OF COAL CONSERVATION.

(Concluded from page 126.)

Future Standards of Public Gas Supplies.

It is, however, manifest that were such proposals as the foregoing to be adopted, either wholly or in part, the whole question of the "standards" of public gas supplies would have to be reviewed and radically altered. The public would in future be supplied with a practically non-luminous gas of much lower calorific value, but somewhat higher calorific intensity, than that to which they have hitherto been accustomed. And, also, the new gas would, on account of its high CO and low CH_4 contents, not only be more poisonous, but also have a wider range of explosibility with air, than the old-fashioned coal gas. It would indeed be a totally different kind of gas, and possibly the British public would not take kindly to it, in which case the business of the gas industry would undoubtedly suffer.

A very important proposal has recently been put forward by Dr. Charles Carpenter, the Chairman of the South Metropolitan Gas Company, namely, that in future gas shall always be sold on a thermal basis only, and that the consumer shall be charged, not so much per 1,000 cubic feet, as hitherto, but so much

per 100,000 B.Th.U.'s supplied to him. Let us see how this is likely to work out.

It may be at once admitted that this new proposal* has many advantages, and, on the face of it, it is eminently fair. The consumer will know what he is buying, and the undertaking supplying him will no longer be able to charge him for a lot of "inert" gases that, under the present system of charging by "volume," are often sent out in the gas. It would no longer be possible for gas managers to draw air through their retorts with a view to increasing their gas yields and revenues, and gas undertakings would not benefit, but rather lose, by such questionable practices. From this point of view, I like Dr. Carpenter's proposal.

There are, however, certain objections—I do not say fatal objections—to it, which ought to be considered at this stage. In the first place, the new proposal seems to involve another proposition, namely, that the economic value of a gas can be referred to a purely thermal basis, irrespective of its chemical composition and of the concentration of the energy in it. It brings to mind an expression, coined in the gas industry, that "one B.Th.U. is as good as another." With a person who is unfamiliar with the chemistry of combustion, such a plausible expression may find favour; but no chemist who views the matter from an independent standpoint, in the light of present-day knowledge, is likely to subscribe to it, and I venture to deny it. Time does not permit of my examining this popular dictum as thoroughly as I should like, but I will, as briefly as possible, indicate some of the grounds of my objection to it.

First of all, taking the question of "concentration," I venture to think that it is not altogether a matter of indifference to the community whether the public mains are used to convey a gas of, say, 600 or of 400 B.Th.U.'s per cubic foot. And if I want to feed a large furnace, it matters a good deal which of the two gases I am supplied with. Also, I am prepared to advance, if need be, a number of valid reasons, proved on scientific investigation and supported by practical experience, why the chemical composition of a gas, as well as its thermal value, is of importance to a consumer.

Next, let us consider the matter for a moment from the standpoint of public safety and convenience, remembering that whoever uses gas has to burn, not gas alone, but an explosive mixture. It would be foolish to frame a policy on the supposition that gas is used by scientific and technical people only. On the contrary, it is mainly used by a great variety of inexpert people, from Mary Jane in the kitchen upwards. And when such people have to use cooking and heating appliances involving the burning of explosive gas and air mixtures, it is necessary that the conditions should be rendered as safe and foolproof as possible for them.

From this point of view, it is important to compare the properties of the three chief constituents of coal gas and water gas, namely, methane, hydrogen, and carbonic oxide, in somewhat the following manner:—

Comparison Between Methane, Hydrogen, and Carbonic Oxide.

	Methane.	Hydrogen.	Carbonic Oxide.
Gross and Net Calorific Values B.Th.U.s per cubic foot at N.T.P.	1064 951	843 287	341
Range of Explosibility of Mixture with Air — per cent Gas	5·6 to 14·8	4·1 to 71·5	12·4 to 73·0
Relative Radiation from Flames	4·4	1·0	2·4

Thus it will be seen (1) that a cubic foot of methane represents about three times as much potential energy as a cubic foot of either hydrogen or carbonic oxide; (2) that methane has a very much narrower range of explosibility with air than either of the other two; and (3) that there are wide differences between the "radiating" powers of their flames. Moreover, in small pipes (2 to 3 in. diameter) the rate of propagation of flame through the most explosive mixture of methane and air is comparatively small (not greater than 100 centimetres per second); on the other hand, the most explosive hydrogen-air mixture will propagate flame at the rate of 500 centimetres per second. Lastly, whilst it is very difficult (some would perhaps say impossible) to set up " detonation " in methane-air mixtures at the atmospheric pressure, it is comparatively easy to do so in hydrogen-air mixtures, which really develop dangerous explosions. If the advocates of the new proposal are prepared to argue that it is a matter of indifference whether or not the gas supplied to the public has a wide range of explosibility or not, I must beg leave to disagree with them, and to stipulate that it should contain a certain minimum proportion of methane in order to render it safe and convenient to be handled by ordinary people.

Or again, let us compare the properties of hydrogen and carbonic oxide, which in this connection have a peculiar interest because their calorific values per cubic foot are nearly the same. Therefore, some may say, it is immaterial whether a consumer is supplied with one or the other of them. Wait, however, until he has an escape, and it may make all the difference between this world and the next for him according to which of the two he has. Or, supposing his pipe system is immune from such an accident, and that he is using the gas either for furnace purposes or in a gas engine, he will soon find out that on acount of its superior " radiating " power and slower rate of flame propagation, carbonic oxide is far preferable to hydrogen for such purposes. Indeed, any steelworks manager will tell you that whilst he wants the producer gas supplied to his open-hearth furnace to contain a large proportion of carbonic oxide, he would object to the presence in it of more than about 12 per cent of hydrogen. Also, in running large gas engines for power generation in connection with iron and steel works, we know how much better they work on a gas whose combustible constituents are mainly carbonic oxide than on one correspondingly rich in hydrogen. And I venture to think that anyone who has closely studied the modes of combustion of the two gases will also come to the same conclusion.

* Since the lecture was delivered, the proposal has been recommended by the Fuel Research Board to the Board of Trade Parliamentary Paper Cmd. 108); it has also been reviewed by the British Association Fuel Economy Committee in their second report, published in September, 1919.

I therefore put it to the gentlemen who are propounding these problems for us, that it is not true to say it is a matter of indifference as to how the potential heat units are present in a public gas supply; and that the cumulative results of scientific research, and supported as they undoubtedly are by practical experience on large-scale working, prove that the fundamental properties of the explosive mixtures formed by different combustible gases with air, arising from their own chemical properties and modes of combustion, do affect profoundly their uses for power and heating purposes. Moreover, in regard to a domestic gas supply, I would add that public safety and convenience alike require that it should not be allowed to contain more than a certain maximum proportion of carbonic oxide and less than a certain proportion of methane; and I would suggest provisionally that these limiting proportions might well be fixed at 20 per cent in each case.

In conclusion, I would like to urge that a question of such moment should not be finally decided without reference to some *ad hoc* committee, specially set up for the purpose, which shall be representative of the ablest and most experienced scientific men and technologists who have specially studied carbonisation, gaseous combustion, and industrial heating problems, many of whom have as yet had no opportunity of expressing their views on the matter. And considering that there is no great urgency about it, I deprecate any undue haste in coming to a decision, and especially any attempt to "rush" through legislation, or even departmental regulations on the subject, before all parties (and particularly those representing the general consumer) have been fully heard.

I am decidedly of the opinion that the gas industry ought not to be allowed an unrestricted freedom, which some of its extreme partisans apparently desire, with regard to the quality and composition of the commodity which it supplies, and that its voice ought not to predominate in the matter. It has rightly set up and maintained its own committees to investigate and report upon its problems; but whilst their findings will command respectful attention, public policy requires that they shall not be accepted without reference to some quite neutral tribunal. For it is the public interest, and not that of the industry, which must predominate in the final settlement of all such questions. I believe that great changes in the present methods of manufacturing gas are both necessary and inevitable, and that, subject to the modifications and safeguards already indicated, Dr. Carpenter's proposed reform in regard to the selling basis of gas is one which, in principle, might well be adopted.

(Concluded.)

DEMAND FOR MOTOR CARS IN CANADA.—The following note has been received from a member of the Institute of Automobile Engineers in Canada, and should be of interest to the industry :—"I wonder if the British makers realise what a demand there is here for the better quality British motor car of about 300 cubic inches capacity (six cylinders), in spite of the overwhelming majority (about 99·9 per cent) here of cars made by United States firms. Three cars and six trucks is the record of British automobiles imported into Canada during eight months of 1919, and not all of the cars were new."

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

OFFICIAL LECTURE: "THE LUBRICATION OF BEARINGS." BY J. DAVISON (MEMBER).

THE need for treatises such as this, which help to bridge the gap between text-book data on the one hand and later research and more recent practice on the other, is always real and pressing. Mr. Davison, in this connection, has rendered yeoman service.

The bulk of the paper treats of "perfect film lubrication" as applied to high-speed bearings.

Accounts of Tower's and Goodman's experiments with bath lubrication clear the way for what follows. The author then treats of viscous flow of oil between bearing surfaces. He points out the effect which temperature and bearing width have upon the grading of the oil film. By means of the admirable diagrams we can readily understand why a bearing should be made free to "tilt."

Many readers will doubtless turn with keenest interest to the section on the "tapered film law," specially that part which deals with the application of this principle in the various Michell thrust bearings. Need one emphasise how largely the pivotal pad thrust block functions in modern steam turbine work? Had the author referred to what Mr. H. T. Newbigin founds as regards the heating effect due to eccentric as against central pivoting this might have been of interest.

Anticipating the application of the tapered film principle to high-speed journal bearings, Mr. Davison instances the case of H.M.S. Mackay, where the experiment has been tried. He deals with journal bearings generally, and gives a table of clearances suitable for oil-flooded high-speed bearings. Any discussion which this paper may call forth should at least take account of such matters as clearances and temperatures. There is here excellent opportunity for those who possess, and are free to divulge, reliable and up-to-date information to render signal service to their fellow-engineers.

Notes on the cleanliness of oil bring to a term the larger part of the lecture. The author emphasises the urgent need for improved methods of filtration.

Finally, with respect to partially-lubricated systems, briefly, but succinctly, Mr. Davison treats of the number and position of transverse oil grooves, circulation of oil, and the accuracy necessary in workmanship.

The appendix is an invaluable asset. It comprises practical hints for regulating the viscosity of oil.

Interested readers should not only read, but re-read this paper.

OFFICIAL LECTURE: "THE AEROPLANE FROM A STRENGTH POINT OF VIEW." BY G. A. STEPHENS, B.SC. (MEMBER).

This long paper were it twice its length would yet be one-half too short for anything approaching exhaustive treatment of such a subject. The writer, however, has concentrated upon essentials. His detail work is effectively suggestive. Greater elaboration and abstruse mathematics must be sought in directions where time and space do not impose insuperable limits. A recent number of *Engineering* contains many columns devoted to the treatment of one section of this subject alone. There is sufficient infor-

mation here for the ordinary needs of the draughtsman designer or other technical engineer. Adequate theory is provided, and it is suitably applied.

The paper deals with one type of aeroplane only. It is no blind formula method which Mr. Stephens presents, however. Thus the reader has placed in his hands the serviceable tool of first principles, and he can apply this to the varied conditions he is likely to meet.

Most excellent are the remarks on specific tenacity. This "strength for weight" factor, so crucial in aerodynamics, should find an ever-increasing vogue, Metallurgical research is yet in long clothes. We confidently await developments in this direction.

The suggestion that under peace conditions the factor of safety should be double that sanctioned for purposes of warfare is both timely and sound pleading.

In his reference to the calculations possible on fin and rudder parts, the author admits that these are at best but rough approximations. Time, experience, and, above all, experimental work are necessary here, as in many other directions also, if really reliable data is to be secured.

If the practice, instanced in this paper, of building up theory by testing a machine experimentally to destruction were emulated by other industries, our knowledge would grow and our assumptions diminish. That is a result to strive after.

Perhaps an additional column, in the table giving properties of materials, for safe stress values, might have been of some service.

Mr. Stephens has succeeded admirably in presenting a suggestive, an illuminating paper.

* Price to members 1s. each; to non-members 2s. each.

W. Roland Needham.

EXTRACTS FROM AN ENGINEER'S NOTEBOOK.

By "Practicus."

Scaling Internal-Combustion Engine Cylinders.

Water jackets of internal-combustion engine cylinders that have become furred up or scaled as a result of using hard circulation water may effectively be cleaned by adopting the following method.

Disconnect the flow and return pipes at the flanges, drain the cylinder jacket, bolt on a blank flange at the bottom connection, then prepare a strong solution of spirits of salts (muriatic acid) in the proportion of one of acid to four of water. Pour this through a funnel into the upper connection of the water space, and fill quite full. Allow this to stand for at least four hours, and as effervescence takes place, causing gas and solution to bubble over, replace the amount of wastage with pure acid. When effervescence has entirely ceased, which denotes that dissolution of the scale is complete, drain the liquid off and wash out thoroughly with plenty of clean water, a hose supply being best. Protect all bright parts of the engine by smearing with tallow, otherwise the fumes generated will rust them.

Cylinder Dimensions and Power Development.

A fairly safe and reliable method of ascertaining the approximate power development of internal-combustion engines is afforded by comparing piston displacement ratios. Thus an allowance of 3.5 cubic feet of piston displacement per minute, in the case of a well-designed oil engine, is roughly equivalent to 1 horse-power delivered. This figure also stands good in the same proportion for gas engines using town's gas of a calorific value of 450—500 B.Th.U.'s per cubic foot. In the case of a gas engine using producer gas of a value ranging between 150 to 180 B.Th.U.'s per cubic foot, an allowance of 4 cubic feet of piston displacement per minute represents the equivalent of 1 horse-power.

Calculating Power of Motors for Electric Cranes.

The following is a simple method of calculating what power motors are required for given crane duties when maximum load to be lifted per minute, cross-traverse and travelling speeds, weight of crab and running gear are known. Thus assuming these values to be, respectively, 15 tons at 10 ft. per minute, traverse speed 50 ft. per minute, travelling speed 200 ft. per minute, weight of crab four tons, girders, cradles, etc., nine tons—these making up a concrete example with which on one occasion the writer had to deal.

Then the horse-power required to be developed by the lifting motor would be $\text{H.P.} = \frac{L \times S}{33{,}000}$ (where L = load in pounds to be lifted S = speed of lift in feet per minute) $= \frac{33{,}600 \times 10}{33{,}000} = 10.18\ \text{H.P.}$

But allowing a mechanical efficiency of 70 per cent, then—

$$\text{Power of lifting motor} = \frac{10.18 \times 100}{70} = 14.5\ \text{H.P.}$$

Traverse Motor.

$$\text{Horse-power required} = \frac{W \times T \times S}{33{,}000}$$

(where W = weight in tons of crab, including load to be lifted; T = tractive resistance in pounds per ton (take T = 42); S = speed of traverse in feet per minute; =

$$\frac{19 \times 42 \times 50}{33{,}000} = 1.2\ \text{H.P.}$$

Allowing a mechanical efficiency of 70 per cent, then—

$$\text{Power of traverse motor} = \frac{1{\cdot}2 \times 100}{70} = 1.7\ \text{H.P.}$$

Travelling Motor.

$$\text{Horse-power required} = \frac{W \times T \times S}{33{,}000}$$

(where W = weight in tons of crane (crab and load); T = tractive resistance in pounds per ton (take T = 60; S = speed of travel in feet per minute) $= \frac{28 \times 60 \times 200}{33{,}000} = 10.18\ \text{H.P.}$

Allowing a mechanical efficiency of 70 per cent, then—

$$\text{Power of travelling motor} = \frac{10.18 \times 100}{70} = 14.5\ \text{H.P.}$$

Notes on Chimney Construction.

In industrial centres no chimney should be of a height less than 90 feet; this being the minimum allowable in many of the largest Midland and Northern manufacturing towns.

Sectional area, or internal diameter, is dependent upon coal consumption or fire-grate area. According to Professor Henry Adams, the relationship would be—coal consumed per week, 4 tons—75 ft. high; 13 tons—100 ft.; 26 tons—120 ft.; 50 tons—150 ft.; 100 tons—180 ft. Taking into account the height of chimney, then—

$$\text{Sectional area} = \frac{\text{Fire grate area in square feet.}}{1{\cdot}5\ \sqrt{\text{Height in feet.}}}$$

WIDTH OF CHIMNEY BASE.—If square $\frac{1}{10}$ of shaft height; if octagonal $\frac{1}{11}$ of shaft height; if circular $\frac{1}{12}$ of shaft height.

BATTER.— At least $2\frac{1}{2}$ in. for every ten feet of height, or 1 in 48.

THICKNESS OF BRICKWORK.—At least $8\frac{1}{2}$ in. in thickness at the top of the shaft, and for not exceeding 20 ft. below; to increase $4\frac{1}{2}$ in. in thickness for every 20 ft. of additional height measured downwards.

FIREBRICK LINING.—The lining should reach about 20 ft. upwards, and be at least $4\frac{1}{2}$ in. thick. Another rule gives one-fifth the height of the shaft, plus 10 ft.

Calculating Weights for Combined High-steam and Low-water Safety Valve.

This form of valve, common to the Lancashire type of steam boiler, is usually designed that a weight equal to the blowing-off pressure may be hung on the end of the high-steam valve lever, the low-water valve being loaded so as to be in equilibrium at the blowing-off pressure.

Required, say, to know what are the correct weights to place on the control spindle and on the lever for a working pressure of 150 lb. per square inch. Factors required to be known are: area of large valve (*lv*); area of small valve (*sv*); length of lever (*l*); fulcrum (*f*); weight of centre valve, rod, etc. (*wv*).

For example, assume these values to be: lv = 10 square inches; $sv = 2$ square inches; $l = 28$ inches; $f = 2\frac{1}{4}$ inches; $wv = 15$ lb.

The low-water valve being practically a direct loaded valve, the formula becomes $P = \frac{W}{A}$; where P = blowing-off pressure; W = weight in pounds; A = effective area of valve. In this case $150 = \frac{W}{2}$ which gives W a value of 300 lb. From this deduct the total weight hanging on the valve, namely 15 lb., then $300 - 15 = 285$ lb. required.

The formula for the lever valve is $W = \frac{AfP}{l}$; where W A P represents the same value as above, f = fulcrum in inches; l = length of lever. Then

$$\frac{10 \times 2.25 \times 150}{28} = 120.5 \text{ lb.}$$

N.B.—The additional weight usually allowed to ensure valve tightness against ebullition, vibration, etc., ranges between 2 lb. to 5 lb.

Fixing Expansion Bends.

Much diversity of opinion exists as to the correct amount of "draw" to allow in a **U** expansion bend for subsequent compression when the pipe line is under steam temperature. Some assert that a bend should when fixed cold be "drawn" a distance equivalent to the full amount of subsequent expansion in a given length. Others claim that exactly half this amount will suffice. Little fault will, however, be found in the practice of allowing the length of the expansion bend to be just two joint thicknesses short between flange face to flange face, such joints being of the thickness of, say, "Jenkin's 96" sheeting, or a pair of Taylor's corrugated rings.

Flux for Brazing Cast Iron.

Although it is pretty generally agreed that the brazing of cast iron is a more or less impracticable operation, at any rate where strength and reliability is concerned, the writer has found that if the following flux is used, in conjunction with the oxy-acetylene flame, quite good results may be anticipated. Chlorate of potash 4 oz., boracic acid 1 lb., carbonate of iron 3 oz. The whole to be very finely powdered and intimately mixed. It is used dry.

How to Determine the Size of Gas Meter for an Engine.

A useful rule for ascertaining the size (in lights) of the gas meter required for an engine of a given brake horse power is as follows: $3.4 \times$ brake horse power $+ 5$ = size of meter in lights.

For example, suppose an engine of 45 B.H.P. is being erected, the meter required will be: $3.4 \times 45 + 5 = 158$ light meter. In such a case a 150 light meter would suffice.

To Find Size of Supply Pipe from Meter to Engine.

The following rule gives the correct size of gas supply pipe for a given size of meter:—

Meter size (in lights) $\times 0.008 + 0.75$ = bore of pipe in inches. Again, assuming an engine of 45 B.H.P., and a 150 light meter we have: $150 \times 0.008 + 0.75 = 1.95$ inches. Or, say, a supply pipe 2 in. internal diameter.

Another rule for obtaining the diameter of the supply pipe, when only brake horse power of the engine is known, is as follows: brake horse power $\times 0.027 + 0.75$ = internal diameter in inches.

Cement for Plugging a Defective Economiser Tube.

When it is desired to make a temporary repair to a defective tube of an economiser by plugging each end of it, the following cement is recommended as being very effective: Take 80 parts of fine cast iron borings to 1 part by weight of sal ammoniac, mix the borings to a stiff paste with water, then add the sal ammoniac in fine powder form, and well mix. Ram well down into both ends of the tube, using wooden plugs driven tightly down to the required depth, in order to form a stop for the cement.

To Calculate the Speed of an Induction Motor.

The speed of an induction motor, when running light, depends upon the number of cycles per second of the supply current, together with the number of poles with which the motor is provided.

$$\frac{\text{Frequency of Cycles} \times 120}{\text{Number of Poles}} = \text{Revolutions per minute.}$$

The speed thus obtained is termed synchronous speed.

(To be continued.)

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 66 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 3 16	11 3 4	0 17 2 20	1 3 2 8	1 9 1 24	1 15 1 12	2 1 1 0	2 7 0 16	2 13 0 4	0
1	0 2 10	6 1 26	12 1 14	0 18 1 2	1 4 0 18	1 10 0 6	1 15 3 22	2 1 3 10	2 7 2 26	2 13 2 14	1
2	1 0 20	7 0 8	12 3 24	0 18 3 12	1 4 3 0	1 10 2 16	1 16 2 4	2 2 1 20	2 8 1 8	2 14 0 24	2
3	1 3 2	7 2 18	13 2 6	0 19 1 22	1 5 1 10	1 11 0 26	1 17 0 14	2 3 0 2	2 8 3 18	2 14 3 6	3
4	2 1 12	8 1 0	14 0 16	1 0 0 4	1 5 3 20	1 11 3 8	1 17 2 24	2 3 2 12	2 9 2 0	2 15 1 16	4
5	2 3 22	8 3 10	14 2 26	1 0 2 14	1 6 2 2	1 12 1 18	1 18 1 6	2 4 0 22	2 10 0 10	2 15 3 26	5
6	3 2 4	9 1 20	15 1 8	1 1 0 24	1 7 0 12	1 13 0 0	1 18 3 16	2 4 3 4	2 10 2 20	2 16 2 8	6
7	4 0 14	10 0 2	15 3 18	1 1 3 6	1 7 2 22	1 13 2 10	1 19 1 26	2 5 1 14	2 11 1 2	2 17 0 18	7
8	4 2 24	10 2 12	16 2 0	1 2 1 16	1 8 1 4	1 14 0 20	2 0 0 8	2 5 3 24	2 11 3 12	2 17 3 0	8
9	5 1 6	11 0 22	17 0 10	1 2 3 26	1 8 3 14	1 14 3 2	2 0 2 18	2 6 2 6	2 12 1 22	2 18 1 10	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	5·5	11·0	16·5	22·0	27·5	1 5·0	1 10·5	1 16	1 21·5	1 25·0	2 4·5	2 10	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 66 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Ft.
0	..	2 18 3 20	5 17 3 12	8 16 3 4	11 15 2 24	14 14 2 16	17 3 2 8	20 12 2 0	23 11 1 20	26 10 1 12	0
10	0 5 3 16	3 4 3 8	6 3 3 0	9 2 2 20	12 1 2 12	15 0 2 4	17 19 1 24	20 18 1 16	23 17 1 8	26 16 1 0	10
20	0 11 3 4	3 10 2 4	6 9 2 16	9 8 2 8	12 7 2 0	15 6 1 20	18 5 1 12	21 4 1 4	24 3 0 24	27 2 0 16	20
30	0 17 2 20	3 16 2 12	6 15 2 4	9 14 1 24	12 13 1 16	15 12 1 8	18 11 1 0	21 10 0 20	24 9 0 12	27 8 0 4	30
40	1 3 2 8	4 2 2 0	7 1 1 20	10 0 1 12	12 19 1 4	15 18 0 24	18 17 0 16	21 16 0 8	24 15 0 0	27 13 3 20	40
50	1 9 1 24	4 8 1 16	7 7 1 8	10 6 1 0	13 5 0 20	16 4 0 12	19 3 0 4	22 1 3 24	25 0 3 16	27 19 3 8	50
60	1 15 1 12	4 14 1 4	7 13 0 24	10 12 0 16	13 11 0 8	16 10 0 0	19 8 3 20	22 7 3 12	25 6 3 4	28 5 2 24	60
70	2 1 1 0	5 0 0 20	7 19 0 12	10 18 0 4	13 16 3 24	16 15 3 16	19 14 3 8	22 13 3 0	25 12 2 20	28 11 2 12	70
80	2 7 0 16	5 6 0 8	8 5 0 0	11 3 3 20	14 2 3 12	16 1 3 4	20 0 2 24	22 19 2 16	25 18 2 8	28 17 2 0	80
90	2 13 0 4	5 11 3 24	8 10 3 16	11 9 3 8	14 8 3 0	16 7 2 0	20 6 2 12	23 5 2 4	26 4 1 24	29 3 1 16	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	29 9 1 4	58 18 2 8	88 7 3 12	117 17 0 16	147 6 1 20	176 15 2 24	206 5 0 0	235 14 1 4	265 3 2 8	294 12 3 12	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 67 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	5 3 26	11 3 24	0 17 3 22	1 3 3 20	1 9 3 18	1 15 3 16	2 1 3 14	2 7 3 12	2 13 3 10	0
1	0 2 11	6 2 9	12 2 7	0 18 2 5	1 4 2 3	1 10 2 1	1 16 1 27	2 2 1 25	2 8 1 23	2 14 1 21	1
2	1 0 22	7 0 20	13 0 18	0 19 0 16	1 5 0 14	1 11 0 12	1 17 0 10	2 3 0 8	2 9 0 6	2 15 0 4	2
3	1 3 5	7 3 3	13 3 1	0 19 2 27	1 5 2 25	1 11 2 23	1 17 2 21	2 3 2 19	2 9 2 17	2 15 2 15	3
4	2 1 16	8 1 14	14 1 12	1 0 1 10	1 6 1 8	1 12 1 6	1 18 1 4	2 4 1 2	2 10 1 0	2 16 0 26	4
5	2 3 27	8 3 25	14 3 23	1 0 3 21	1 6 3 19	1 12 3 17	1 18 3 15	2 4 3 13	2 10 3 11	2 16 3 9	5
6	3 2 10	9 2 8	15 2 6	1 1 2 4	1 7 2 2	1 13 2 0	1 19 1 16	2 5 1 24	2 11 1 22	2 17 1 20	6
7	4 0 21	10 0 19	16 0 17	1 2 0 15	1 8 0 13	1 14 0 11	2 0 0 9	2 6 0 7	2 12 0 5	2 18 0 3	7
8	4 3 4	10 3 2	16 3 0	1 2 2 26	1 8 2 24	1 14 2 22	2 0 2 20	2 6 2 18	2 12 2 16	2 18 2 14	8
9	5 1 15	11 1 13	17 1 11	1 3 1 9	1 9 1 7	1 15 1 5	2 1 1 3	2 7 1 1	2 13 0 27	2 19 0 25	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 5·58	0 11·1	0 16·7	0 22·3	0 27·9	1 5·5	1 11	1 16.6	1 22·2	1 27·8	2 5·4	2 11	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 67 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Ft.
0	.	2 19 3 8	5 19 2 16	8 19 1 24	11 19 1 4	14 19 0 12	17 18 3 20	20 18 3 0	23 18 2 8	26 18 1 16	0
10	0 5 3 26	3 5 3 6	6 5 2 14	9 5 1 22	12 5 1 2	15 5 0 10	18 4 3 18	21 4 2 26	24 4 2 6	27 4 1 14	10
20	0 11 3 24	3 11 3 4	6 11 2 12	9 11 1 20	12 11 1 0	15 11 0 8	18 10 3 16	21 10 2 24	24 10 2 4	27 10 1 12	20
30	0 17 3 22	3 17 3 2	6 17 2 10	9 17 1 18	12 17 0 26	15 17 0 6	18 16 3 14	21 16 2 22	24 16 2 2	27 16 1 10	30
40	1 3 3 20	4 3 3 0	7 3 2 8	10 3 1 16	13 3 0 24	16 3 0 4	19 2 3 12	22 2 2 20	25 2 2 0	28 2 1 8	40
50	1 9 3 18	4 9 2 26	7 9 2 6	10 9 1 14	13 9 0 22	16 9 0 2	19 8 3 10	22 8 2 18	25 8 1 26	28 8 1 6	50
60	1 15 3 16	4 15 2 24	7 15 2 4	10 15 1 12	13 15 0 20	16 15 0 0	19 14 3 8	22 14 2 16	25 14 1 24	28 14 1 4	60
70	2 1 3 14	5 1 2 22	8 1 2 2	11 1 1 10	14 1 0 18	17 0 3 26	20 0 3 6	23 0 2 14	26 0 1 22	29 0 1 12	70
80	2 7 3 12	5 7 2 20	8 7 2 0	11 7 1 8	14 7 0 16	17 6 3 24	20 6 3 4	23 6 2 12	26 6 1 20	29 6 1 0	80
90	2 13 3 10	5 13 2 18	8 13 1 26	11 13 1 6	14 13 0 14	17 12 3 22	20 12 3 2	23 12 2 10	26 12 1 18	29 12 0 26	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	Weight.
	29 18 0 24	59 16 1 20	89 14 2 16	119 12 3 12	149 11 0 9	179 9 1 4	209 7 2 0	239 5 2 24	269 3 3 20	299 2 0 16	

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PRODUCER GAS FOR MOTOR VEHICLES.

By D. J. Smith.

(*Continued from page 175.*)

As the fuel is consumed, a layer of ashes is deposited on the bars, which unless periodically removed, deadens the fire and the production of gas falls off. To remove these ashes, a firedoor has to be opened so that they may be raked out by the attendant, and this has to be carried out quickly, or air will enter which may stop gas production or cause an explosion in the producer.

The deep bed of fuel also burns hollow, which tends to stop the full gas production. If this is knocked in by the attendant, the resulting disturbance generally destroys the production of gas so that the engine stops, and the producer has to be fanned up to get it to work again. The poking of the fire, to destroy or prevent these hollows, has to be carried out by the attendant through small holes normally closed by plugs, and as it is impossible to see what is happening, it is not a very efficient operation.

The feeding of the fuel is performed by hand, and the fuel passes through an air lock, as it is essential that no air be allowed to leak into the generator during the operation. If, as occasionally happens, the attendant leaves both doors of the air lock open, either the engine stops or an explosion occurs. With fuel bed in this manner, it is quite obvious that there is at one time too much fuel in the producer, and at another too little. In any case, there is no connection between the quantity of fuel fed and the work that is being done, and, therefore, the quality of the gas must be very variable.

The supply of water to the producer is a most important point, in view of the part played by the water vapour in the composition of the gas. The control of this is generally left to the attendant, who regulates it without anything to guide him as to the quantity required, though in one or two cases the suction of the engine is made to control the feed of water, but even here there is no definite regulation.

The inflexibility of the ordinary producer is bound up with the lack of control of the water supply and the form of fire bed used. If it is assumed that a producer is working on a steady load, air is being drawn over the surface of the water in the vaporiser and takes up a certain quantity of steam. If the load is suddenly increased, more air would pass over the water, but no increase of steam would be available; in fact, the tendency would be to cool the water down and decrease steam production. The gas would therefore be of lower quality, and the engine, instead of responding to the increased load, would stagger and possibly stop. Even if the steam were available, the fire, possibly with a layer of ashes between it and the bars and a bed of dead fuel above it, cannot respond rapidly, and would be cooled out by the sudden increase of steam drawn through it, and the quality and quantity of the gas would be still further reduced.

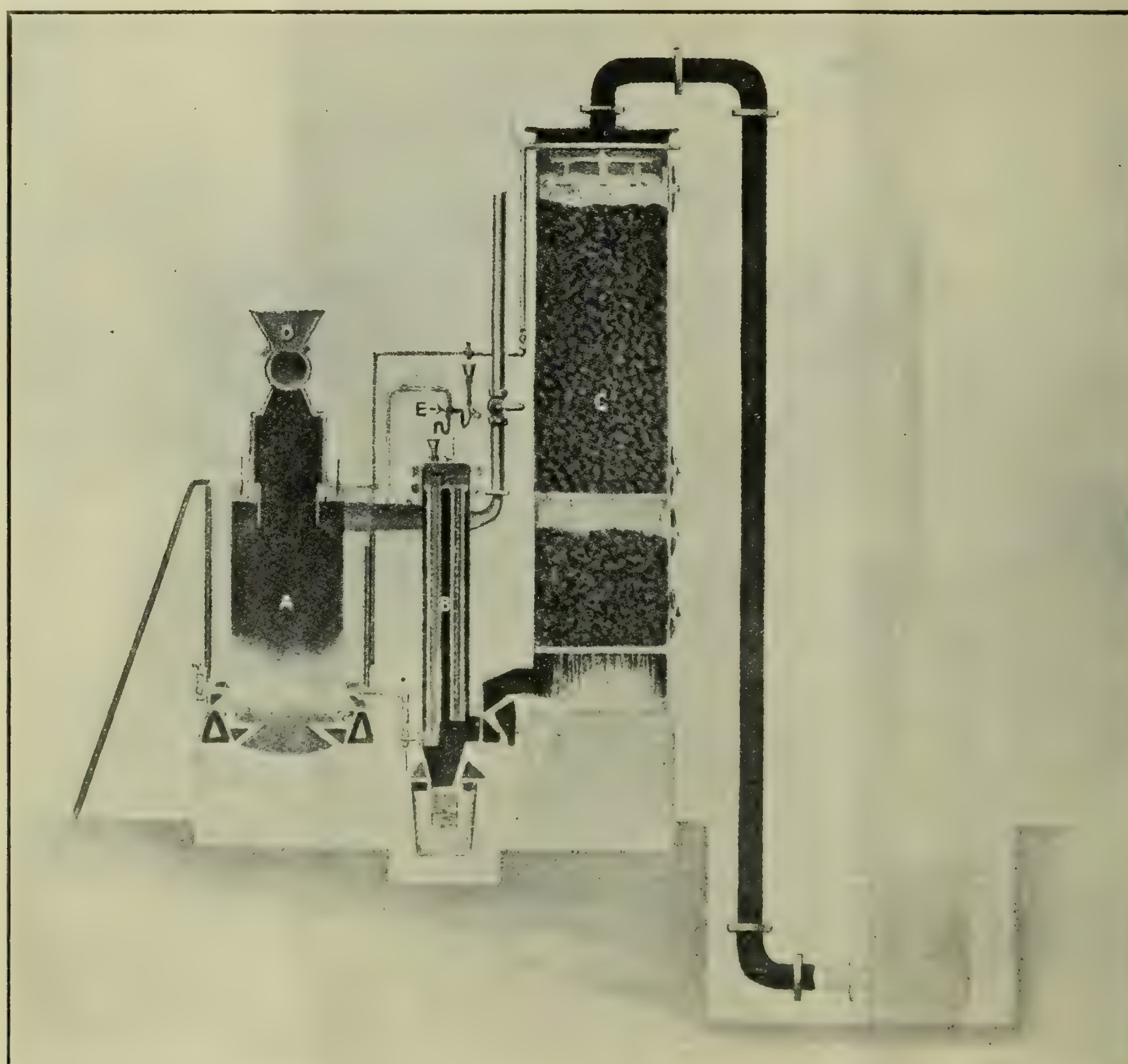
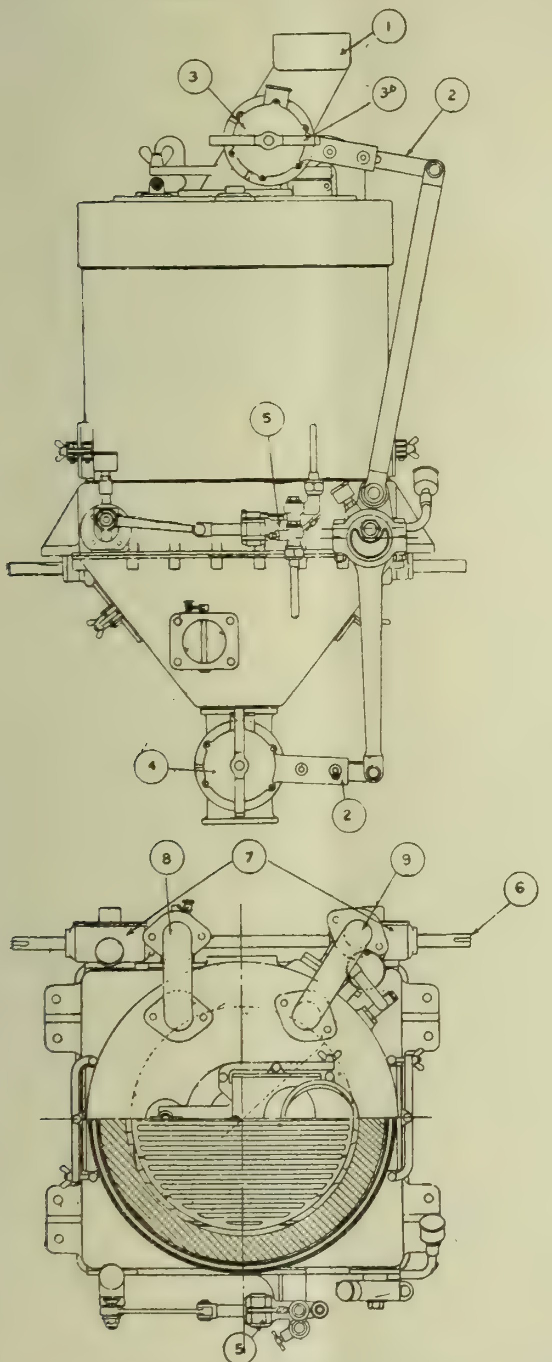


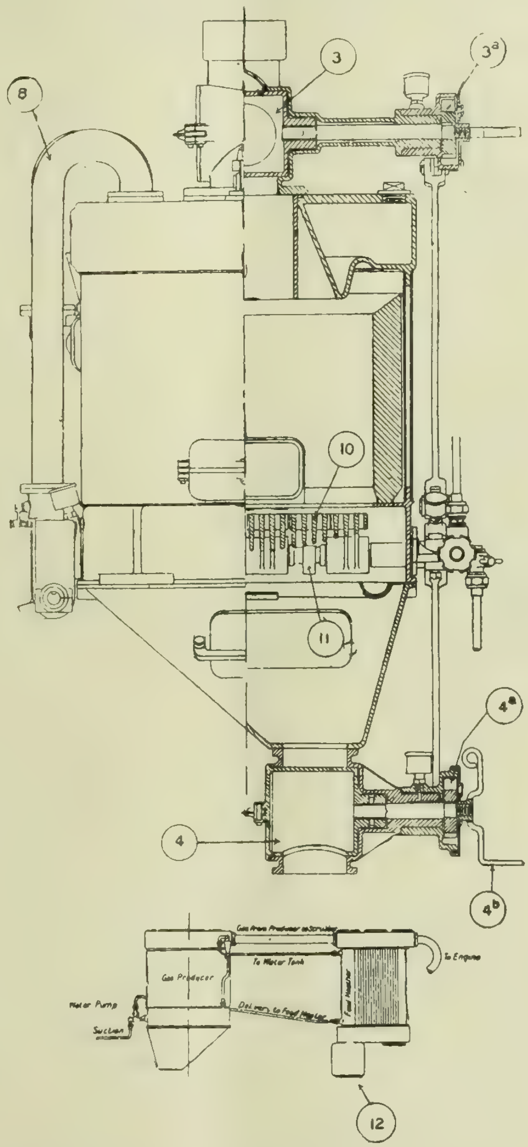
Fig. 2.

When, about 10 years ago, the author first began to give this matter attention, engine flexibility was not considered of such importance on commercial vehicles, and it did not then appear that it would be a great drawback if a constant speed engine had

to be used with producer gas. The most serious trouble that had to be faced was the cleaning of the gas, and it did not appear possible in the restricted space available on a motor vehicle to fit a satisfactory scrubber that would deal with the gas given off, which contained certain volatile matter as well as dust, and, therefore, had to be washed or scrubbed before it could be used in the engine. The great size and weight of the producer, even when reduced as much as possible, also rendered the scheme impracticable, and the author determined to depart from standard practice and evolve a suitable producer for vehicle work. One reason for the great size of the normal design of producer is the fact that a very large quantity of fuel is carried in it at all times, see Fig. 2, Plate II., and in this it resembles the old surface carburettor.

The need for this deep fuel bed, apart from the fact that it permitted of fewer openings of the doors for stoking, was not clear to the author, yet the standard authorities admitted no escape. Latta, for instance, states that the fuel bed of a producer using anthracite peas should be not less than 30 in. deep to give the best results, while with larger fuel and coke another





Figs. 3 and 4.—General Arrangement of the D. J. Smith Portable Gas Producer Plant.

1. Fuel Inlet Pipe.
2. Adjustable Fuel Feed and Ash Discharge Gear.
3. Fuel Feed Valve.
3a. Friction Drive for Feed Valve.
3b. Handle for independent Hand Operation of Feed Valve. (Note that the position of the handle indicates the location of the feed aperture.)
4. Ash Discharge Valve.
4a. Friction Drive for Ash Discharge Valve.
4b. Handle for Ash Discharge Valve. (Similar to that on Fuel Feed Valve.)
5. Water Pump.
6. Main Operating Gear Shaft driven direct from engine.
7. Totally enclosed and continuously lubricated Driving Gear for the Fire Bar Cam Shafts ; these also drive the Water Pump, Fuel Feed Valve and Ash Discharge Valve.
8. Pipe conveying steam and air to the underside of the fire.
9. Air Supply Pipe from interior of jacket to vaporiser.
10. Fire Bars, alternate sections pivoted at alternate ends, the free ends being vibrated section by section and successively by Cams on Revolving Shafts.
11. One of the Cams for vibrating the Fire Bars.
12. Diagrammatic arrangement of Producer and Scrubber.

12 in. or so was necessary. This in itself made the producer very large, and also called for the presence of a hundredweight or so of coal in the producer itself.

The fuel bed in an ordinary producer is divided into zones

(1) The ash zone.

(2) The combustion zone.

(3) The decomposition zone.

(4) The distillation zone.

The second zone is the one in which the actual work is done, the rest give trouble, especially the first and fourth, the gradual deepening of the first deadening the fire and needing periodical clearing away, which could only be done with the engine stopped, and the fourth giving off the volatile constituents of fuel, which it was almost impossible to eliminate on a motor vehicle. The author, therefore, built a producer in which only the combustion zone existed.

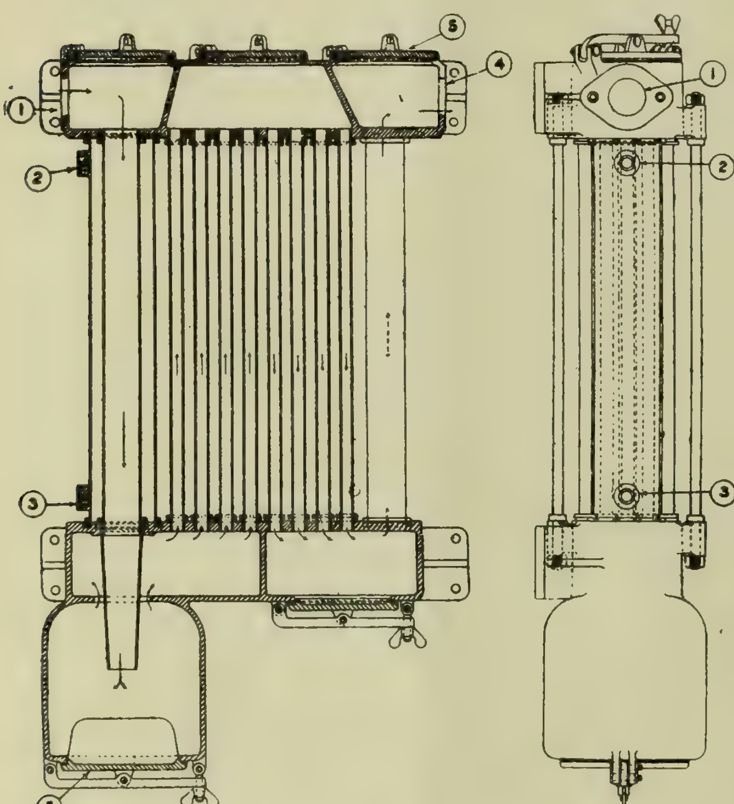


Fig. 5.

The Scrubber for D. J. Smith's Portable Suction Gas Producer Plant. It is a Dry Scrubber.

1. Gas Inlet Branch. 2. Water Outlet Branch. 3. Water Inlet Branch. 4. Gas Outlet Branch. 5. Quickly opened Cleaning Doors.

The arrows show the direction of flow of the gas. The water circulates upwards past the first down-tube.

To keep this thin bed of fuel wholly as a combustion zone and to maintain its shallowness, two things were necessary: (1) A regular feed of fuel in small measured quantities. (2) Continuous agitation of the whole fuel bed, in order that no channels or holes in the fire may occur and that all ash may be constantly sifted out and the fuel bed kept light and porous to give easy passage to the air and water vapour through it. The depth of the furnace chamber in the producer was approximately 12 in., the depth of fire being only about 6 in., all of which, while working, was incandescent.

Since the fresh fuel was regularly fed, it was at once sifted into the incandescent mass of fuel and all volatile constituents were eliminated, the hot zone above the fire in the producer chamber dealing with those not broken up in the fire. This method of working quite eliminated the drawbacks due to the distillation of the fuel and the passing over of any volatile constituents which could give trouble in the engine, and not only could anthracite be used, but also other fuels containing a fairly high percentage of volatile constituents.

The author is fully aware that it is generally regarded as impossible to work a suction gas producer successfully with such a thin bed of fuel, but he can only state that it does work and works extremely well, and after severe tests has shown no drawbacks. Using anthracite, semi-anthracite, and hard non-caking steam coal, only dust is found in the scrubber. A sample analysis gave :—

Carbon	90·06 per cent.
Volatile matter	5·05 ,,

This was practically the analysis of the fuel which was used, and represented; in fact, merely the dust drawn off by the suction of the engine from the fuel as it fell into the producer and before it could reach the fuel bed.

This method of working also quite eliminated another serious trouble found with a deep fire bed, namely, clinker. This, in ordinary producers, forms rapidly, and by closing up the grate apertures, reduces the yield and quality of the gas. The clinkers also form on the refractory lining of the producer and have to be barred off, a tedious operation and one which rapidly destroys the lining. Clinker is fused ash, and as no ash is allowed to form in the author's system, there is no clinker.

The feed and grate mechanism were driven by the engine of the vehicle, and a mechanical ash discharge was also added. This enabled the size of the producer to be still further reduced by doing away with the necessity of providing an ashpan large enough to contain the ash formed during some hours' running. The necessity for stopping the engine to clear out the ash was also eliminated.

Several important advantages resulted :—

(1) A reduction in size and weight due to the small quantity of fuel carried in the producer.

(2) The elimination of distillation of the fuel with all its troubles.

(3) The prevention of clinker.

(4) A self-acting fuel feed and ash discharge.

The results of the author's early experiments clearly showed that water could not be directly fed to the fire if the best results and extreme flexibiilty were required, so that it must be fed as steam, and that in order to keep the quality of the gas constant the air passing to the producer must be used as the regulating medium for the steam supply. A small vaporiser or boiler was, therefore, fitted to the producer heated by radiation from the fire and the passage of gas through a channel formed in it (see Figs. 3 and 4). As the content of this vaporiser is small, the pump used in the early experiments was retained, and this fed the water to the vaporiser, but in order to economise heat, the water passed first through a water jacket surrounding the gas pipe from the producer (see Fig. 5). This feed heater on the gas exit pipe is a common feature in producer practice, but on vehicle work where no scrubbing or cooling water can be carried, it has an extra value in cooling down the gases as well as increasing efficiency.

The water in the vaporiser being at a temperature of approximately 180 deg.—200 deg. Fah. while the plant is running, the air drawn over the surface of the water picked up water vapour satisfactorily for steady loads, but any sudden increase in the quantity of air admitted did not meet with a corresponding increase in the steam supply, rather the reverse. The author, therefore, fitted a throttle to the air inlet to the vaporiser, through which all air admitted to the producer must pass. This throttle was coupled to the engine throttle, so that as the engine throttle was opened the throttle on the air inlet was partially closed. The result of this was to lower the boiling point of the water in the vaporiser, which then gave off steam freely owing to the drop in atmospheric pressure or slight vacuum to which it was subjected.

This regulation of the steam and air supply in proportion to the gas required gave the necessary flexibility, and also, as steam was available and largely raised on heat which would normally be wasted, no detrimental effect was exercised on the fire, the proportion of air and steam always being maintained, the quantity only varying. The reserve of hot water in the vaporiser is a valuable asset for enabling sudden demands to be met; it really acts in the same manner as an air vessel in a pump, by absorbing the shock of delivery and maintaining a steady output.

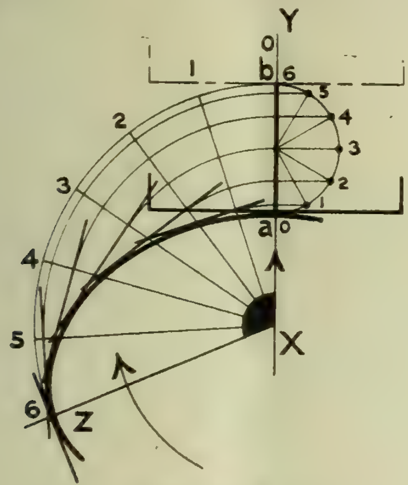
(To be continued.)

CAMS.

By W. E. BENNISON, A.M.I.M.E.

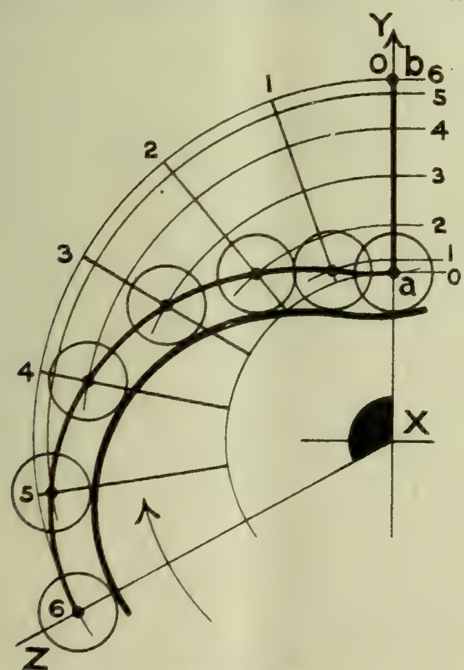
(Continued from page 151.)

VII. Harmonic motion: surface contact; rectilinear motion.—The layout for this is similar to the one for uniform velocity except for the spacing of the follower path. Fig. 34 is the one. Reference is made back to



CAMS.—FIG. 34.

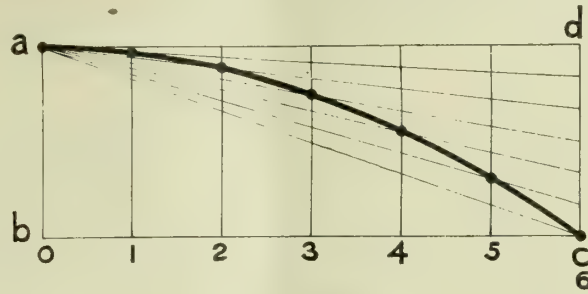
Case IV. (Fig. 29), and the method described there will apply here, excepting the spacing of the points on the line *a b*; these must be spaced according to the harmonic motion of the follower. This is a case where the displacement curve may be dispensed with, and the semi-circle is shown described on the line *a b* itself. Six



CAMS.—FIG. 35.

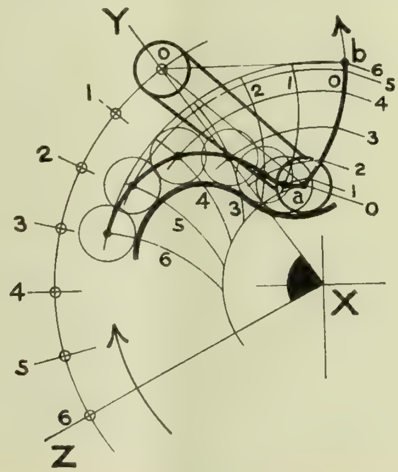
divisions are taken, and the points numbered from 0 to 6. The points on the semi-circle are now projected on to the line *a b*, and the rest of the procedure is as described in Case IV. The cam curve is tangent to the various surface positions obtained.

VIII. Constant acceleration velocity: roller contact; rectilinear motion. (See Fig. 35.)—The usual lettering is adopted, X being the axis, Z X Y the cam angle, and *a b* the follower path, *a b* coincides with X Y and is therefore radial. Various equidistant radial positions are found for *a b* exactly as described in Case I. (Fig. 24). The dividing of the line *a b* involves another type of displacement curve. The point *a* starts from rest, its velocity is constantly accelerated, until on reaching the point *b* at the end of the stroke the velocity has become a maximum. Fig. 36 shows the displacement curve or this type of motion. The horizontal lines *a d* or *b c*



CAMS.—FIG. 36.

represent the circular measure of the cam angle Z X Y and the ordinates 0 to 6 are equally spaced. The height of the diagram is made equal to the length of the follower path, in fact, the lines *a b* may be taken to represent the follower path: for the sake of description, however, the positions of the points *a* and *b* are reversed, the point *a* being at the top and the point *b* at the bottom of the lines. If a heavy particle be imagined to drop from *a* to *b* its velocity will be uniformly accelerated. The displacement curve for such a condition is the parabola, and the motion of the follower is identical with that of a falling body. The axis of the parabola is *a b*, *a* being

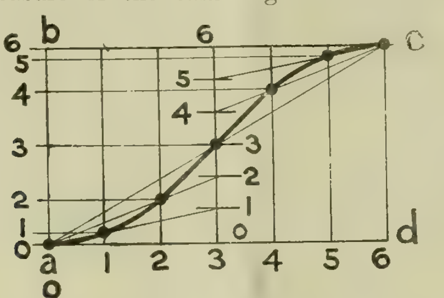


CAMS.—FIG. 37.

the vertex, and *c* is a point on the curve. Any method of drawing the parabola may be used, but the following is the one usually adopted for the conditions :—The line *d c* is divided into any number of equal parts, in this case 6, and the divisions are numbered away from the vertex; that is, the point *d* is 0 and the point *c* is 6. From every point on the line *d c* a diagonal line is drawn to the vertex *a*. The intersection of every one of these lines with the ordinate carrying the same number is a point on the curve. Thus the intersection of the diagonal line 1 *a* with the ordinate 1 is a point on the curve; the intersection of the diagonal 2 *a* with the ordinate 2 is

another point on the curve, and so on. The parabola is then drawn through all the intersections. The length of every ordinate from the curve to the line *a d* can now be stepped off from the point *a* along the follower path in Fig. 35, and the follower path is correctly spaced. These points are now turned round into their respective follower paths, as all the previous cases, and the actual cam curve drawn through the points of intersection.

IX. Constant acceleration and retardation velocity: roller contact; angular movement.—In this case the follower starts from rest and is constantly accelerated until it attains maximum velocity at centre stroke: during the second half of the stroke the velocity is constantly retarded until the follower comes to rest at the end of the stroke. The actuated member is a lever which carries the roller at its free end, and the follower path will be the circular arc *a b*. The lay-out shown in Fig. 37 follows the usual procedure for angular motion and the various curved paths 0 to 6 are laid down as previously described, first by taking fulcrum positions and then describing arcs about these fulcrums with radius equal to the length of the lever. To fix the points on the arc *a b* use is made of the displacement curve shown in Fig. 38. As before, the base line *a d* is the circular measure of the cam angle and the ordinates



Cams.—Fig. 38.

0 to 6 are equally spaced. The height of the diagram *a b* is equal to the curved follower path flattened out. The displacement curve this time will consist of two parabolas, one for the first part of the stroke which is accelerated, and the other for the second part of the stroke which is retarded; the second parabola will be inverted. *a b* is the axis of the first parabola, and *c d* the axis of the second one, *a* and *c* being the vertices. The two parabolas meet at the centre point (3) of the centre ordinate. To construct the parabolas divide the centre ordinate into any number of equal parts, say, 6, numbering the points from the base line *a d* as shown. From the points 1, 2, and 3 thus found draw diagonal lines to vertex *a*; and from the points 3, 4, and 5 draw lines to vertex *c*: the intersections of these lines with the ordinates give points on the curve: thus the intersections of diagonal 1 *a* with ordinate 1, diagonal 2 *a* with ordinate 2, 4 *c* with 4, and 5 *c* with 5 give the required points for the curve, together with the two vertices *a* and *c* and also the point 3 which is common to both parabolas. Each ordinate measured from the line *a d* is the distance which the follower has travelled after a lapse of time represented by the abscissa. The length of each ordinate must now be transferred to Fig. 37 and measured along the arc from the point *a*. The correct points on the follower path are now ascertained, and they must be swung round on to their respective follower path position.

(*To be continued.*)

MODERN STEAM TURBINES.

By J. Humphrey.

(*Continued from page 131.*)

The example of the use of a geared turbine described in the previous article serves to show that the turbine can now be used with marked success for driving industrial establishments without generating electricity. It will, of course, be understood, however, that it may in many cases be advisable to instal a turbo-generator set, and drive the various machines in a works by means of electric motors which enable the speed of various machines to be regulated electrically. Electricity will also eliminate much shafting and belting, and the re-arrangement of machines is also greatly facilitated, since with the electric drive power can be obtained in any position of a works simply by running the necessary cables. Every case must obviously be considered on its merits. Often, it will no doubt be found that a geared exhaust steam turbine will prove advantageous in the way of increasing the power of an existing plant. Such a turbine was installed some time ago in the works of Messrs. Guest, Keen and Nettlefolds, Rogerston, near Newport, Mon. The original power plant at these works consisted of a vertical compound condensing engine, which was used for driving a group of about 18 wire mills, which ranged from cogging mills down to finishing wire rolls, and used for wire having a diameter of $\frac{3}{16}$ of an inch. The engine develops 2,100 indicated horse power, and the turbine which works on the exhaust steam of the main engine increased the power of the plant to 3,000 indicated horse power without any increase whatever in the steam consumption. The turbine is provided with a single pinion which drives two mill shafts running at different speeds, *i.e.*, 500 and 250 r.p.m., the speed of the turbine being 3,700 r.p.m. The two mill shafts are still connected to the engine flywheel by the original rope drive, but the ropes now serve to equalise the power over the different portions of the mill, transmitting power sometimes in one direction and sometimes in the other direction, depending upon which portion of the mill is most heavily loaded.

Another example of the use of a geared turbine is to be found in the Springfield Paper Mill of Messrs. Tod, Jnr., and Co. Ltd., at Polton. The turbine is directly coupled through double-helical gearing to a slow-speed shaft on which is mounted a rope pulley, from which a mill is driven on either side of the turbine by ropes. During a period of four-and-a-half years the plant only lost half-an-hour of the working time, which is not by any means an exceptional record. A very similar machine was installed in the neighbouring paper mills of Messrs. Annandale and Sons Ltd., in January of 1915. In this case, however, the turbine is coupled through a double-helical gearing to a single slow-speed shaft driving a single mill by means of a pulley and ropes. The end of the slow-speed shaft is also directly coupled to a 125-kilowatt dynamo, which supplies power and lighting to the mill. Still another example of the use of geared turbines in a paper mill is to be found in the works of Messrs. A. Pirrie and Co. Ltd., Stoneywood Works, Aberdeen. In addition to using turbines for driving alternators,

this firm has also installed two special "pass-off" geared turbines for driving beaters and breakers. The shaft speed of each of these turbines is 5,000 r.p.m., but they are geared down to give a running speed of 300 r.p.m., the low-speed shaft of the gear box being directly coupled to the mill shaft, which runs on roller bearings and drives by the usual belt arrangement the beaters on the floor above. All the turbines referred to were installed by Messrs. C. A. Parsons, of Newcastle-on-Tyne. This firm has done a great deal in the direction of developing the geared steam turbine, and is now turning out a great many machines of this description. Sir Charles

correct to assert that there is not now a single ship being fitted with turbines directly coupled to the propeller. The use of helical gears enables ships of all speeds to be successfully propelled by steam turbines, and it is said that in this country alone the turbine gears already made and on order represent a total aggregate turbine output of 16,000,000 H.P.

An example of a Parsons' helical gear wheel and pinion is shown in the accompanying illustration, Fig. 101. To obtain silent and smooth running with these high-speed gears, the greatest possible accuracy in cutting the teeth must be aimed at. The teeth in the case of the Parsons' gears are cut

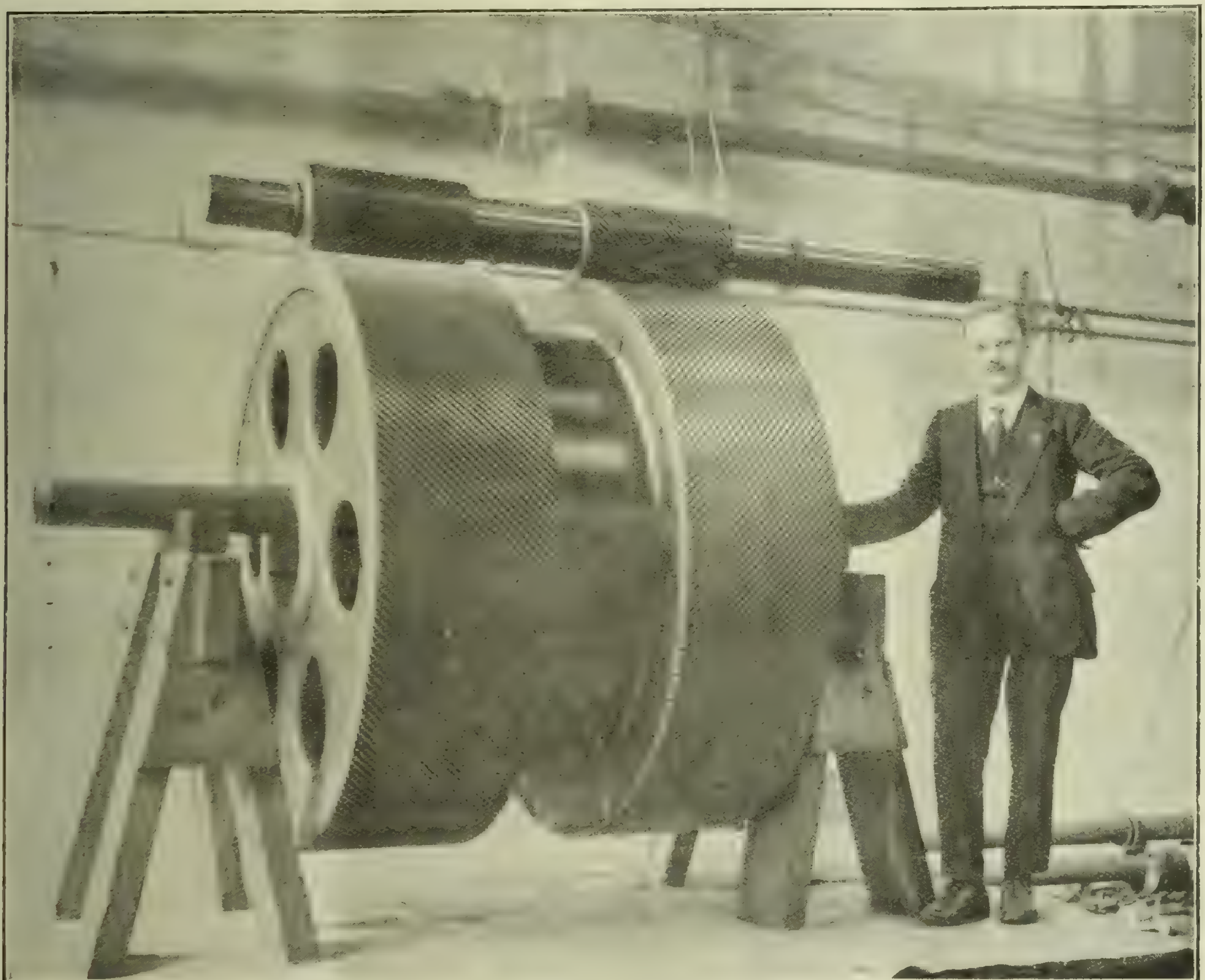


Fig. 101.—A Turbine Gear Wheel and Pinion.

Parsons has always been a keen advocate of gearing for reducing the turbine's speed, and there is no doubt, in the light of recent developments, that his policy is sound. It is common knowledge that the loss involved with properly-designed gears is very small, the efficiency being as high as 98 or 99 per cent. This efficiency cannot be obtained with electrical speed reduction gear, and it is no doubt owing to this fact that British engineers have been opposed to applying the electrical speed reduction system to ships. All recent warships have been fitted with geared turbines, as well as turbine-driven ships for the mercantile marine, and it is probably

with a special kind of hob, which is a cutter in the form of a worm. At the outset great trouble was met with owing to the fact that the master worm wheel which rotated the gear wheel was not quite accurate, and this led Sir Charles Parsons to invent what he terms the "Creep," which causes the gear wheel being cut to revolve at a slightly lower speed than the master worm wheel, and by this means the errors are reduced to about one-eighth of what they would be otherwise, whilst the error is also distributed in spirals on the gear wheel instead of being parallel to the axis. The effect of any wear on the master worm wheel, is therefore minimised by the "Creep,"

and gears are thus made to run smoothly and without making an undue amount of noise. Helical gears of this sort are always made with involute teeth, as the centres can be slightly varied to give the requisite clearance between the teeth. Such gears can also be generated with a hob having straight sides, thus simplifying accurate manufacture. Oil is squirted on to the gears from nozzles which are placed so that the oil jets meet the gear wheel and pinion at the point of contact. The quantity of oil used is about one gallon per minute for each 100 to 150 H.P.. Obviously, the alignment of the gears in the gear case is of the greatest importance. Two principal types of gear cases are used, the rigid type and the floating frame type, invented by Mr. McAlpine. The Parsons' rigid gear, which is the type usually adopted in this country, has a pinion with a centre bearing (see Fig. 101), and the case is well ribbed and rigidly designed so as to support the pinion and gear wheel with a minimum amount of distortion, whilst in the case of the floating frame type, the pinion is in a rigid frame supported in a flexible support.

(*To be continued.*)

CAR DESIGN AND CAR USAGE.

By Edgar N. Duffield.

(*Continued from page 148.*)

Brakes should be so designed as to need very little adjustment short of the periodical replacement of the friction surfaces. The contact surfaces provided to-day are ampler than they were, but still (in only too many cases) quite inadequate. We still find many new cars designed upon the undependable belief that their owners will make most use of their hand-operated brakes. This is obviously, patently wrong. Ever since motorists had foot brakes, they have made most use of foot brakes, and it is reasonable that they should do so.

Years ago American designers gave us foot-applied "service" brakes, the hand-applied "emergency" brakes being intended purely for emergencies, to supplement the action of the service brakes, or to lock the wheels of stationary cars. This would appear to be the logical lay-out of braking arrangements, and it is one that a lot of British and European constructors are now adopting—one of many little tips picked up from America. The brakes of American cars were for years, and still are, notably more efficient than are those of British cars. This is rather strange, in view of what the author knows of American and British road gradients or contours, but it is so. Latterly brakes designed on this side of the Atlantic have been made bigger as to contact surface, and better as to efficiency, but it is still true that a very cheap American car often has better braking efficiency than has quite a good British or European car.

On the point of brake adjustments it should not be necessary to lift more than one floor-board to adjust the hand brake, and the foot brake should be adjustable at no more cost than that of stooping. Here again, some of the least costly cars are much better equipped than are some of the most expensive, simply because designers of good cars forget that users do not buy for the sake of getting a handsome *ensemble*, and give their minds to a really striking *coup d'œil*, instead of paying attention to maintenance details. The more ample the frictional contact surfaces, obviously the more progressive the operation of the brakes, and the less frequently will adjustment be required. In this matter, as in that of lubrication, the less often a car user has to adjust, from compulsion, the more regularly and thoroughly he will adjust. That, anyhow, is the author's experience.

Connections between the pedal and lever operating the brakes and the toggles or cams actually expanding the shoes, or contracting the bands, should be of good steel cable. Cable does not rattle; it is almost micrometrically adjustable as to length and tension and it is easily checked for flaw or wear effects. Solid brake rods always will, always do, chatter, and will generally be found much heavier—for a given duty—than cable need be.

Turning now to less rudimentary things, the author wonders why designers continue to support their motors by lugs or arms cast integrally with the crank-case? One British car in particular, with a very poor War service record, earned that record simply because of the frequent breakage of engine lugs. They were quite irreplaceable on the Eastern fronts, and so soon as a lug went the car was—in most cases—useless. Had those engines been carried upon a couple of girders hung from the main frame, and each car carried a single spare girder among its running equipment, or been credited with one in the base stores, there need have been no serious casualties. Such girders save money, save weight and—if they are interchangeable, as they should be—a single spare is enough to see a man round the world. A motorist with a broken engine lug is a very helpless individual, unless he happens on a Barimar depôt somewhere. Even in default of a spare girder, any respectable smith can work up a girder of sorts, or something that will fit its mounting holes. The massiveness of bearer lugs shows that designers appreciate the duty they have to give, and yet those same designers do not see the obvious appeal of a different type of support.

From the dogs in gear boxes to the castellations on valve caps, all toothed driving surfaces are commonly inadequate for their work. We see far too many gaps and far too light or slight projections. The same applies to driving squares. Efficiency can nearly always be improved by reducing the number, but simultaneously increasing the mass of projection and depth of spacing of castellations, or by reinforcing the working surfaces of squares. In this connection the old time phospher-bronze cardan blocks of the De Dion-Bouton car can often be adapted very profitably when it is desired to reinforce the efficiency of a driving square without undesirable increase of mass or weight, especially if spares are left as cast, with a fair margin of stuff to allow for fitting, or rather for wear in the receiving (or female) member of the connection.

Reference must be made to the spring cover. At the risk of ridicule, Mr. S. F. Edge's figure speech on this may be quoted. He has said, somewhere among his multifarious contributions to motoring wisdom, that to leave axle springs naked is almost as ridiculous as to leave the pinions of gear sets naked. That is true, but the author must confess

that he had never appreciated the fact that the springs of a car do quite as much work with their leaves more or less widely apart as they do with the leaves compressed into a solid mass, as we see them with the car at rest, until spring gaiters were widely advertised, and he began to wonder if they did anything more than add to the revenue of accessory dealers. Long since then he has used them, moved to do so at first because he remembered that the older racing cars generally had their springs lapped with whipcord or waxed twine. He has been surprised to find the real improvement in riding comfort effected by conserving the lubricant and excluding grit and dust. This improvement of running must be experienced to be appreciated. If spring covers are properly made, designed exactly to fit the springs, woven of the flax used for fire hose, and moulded with corrugations at either end, to allow for the elongation and shortening of the springs as they do their work, with proper means of lubrication—one to each cover—as used on the new Arrol-Johnston car, the solution of at least one phase of the eternal suspension problem is being approached.

The author has already indicated his belief in the efficiency—in fact the *sufficiency*—of the plain half-bow (or semi-elliptic) spring, duplicated fore and aft, and although there is a noticeable tendency to use quarter elliptic springs fore and aft on the lighter cars (with the camber downward, toward the eye or shackle, the thicker end of the spring inward, and the eye or shackle outward, at the axle-attachment) he feels that this tendency will not for some time develop beyond the suspension-design of light cars, by which are meant those weighing, in running trim, not more than 10 or 12 cwt.

The author's own experience suggests that excellent suspension for cars of 20 cwt. and more can be got from four semi-elliptic springs, if they are of ample length, width of leaf, slowness of camber, and are well shackled, efficiently gaitered, and thus riding in a perpetual oil-bath. He does not profess to *know*, but he *believes* that there is nothing in between this suspension and pure Lanchester practice. An extra quarter elliptic member in the rear is still used very commonly, but serves very little purpose, and the transverse rear springs adapted from French design—with the idea of checking the tendency to roll in cornering, set up by *too* flexible rear springs—are, he is convinced, quite useless, unless they are so robust as to dominate the longitudinal springs. As soon as they do this they become the master springs of the lay-out, and thus we might as well frankly adopt Ford rear suspension. Incidentally, Ford suspension is excellent—for Fords. With their weight-disposition, empty or laden, nothing could be better. This is merely one of many matters in which the Ford is a much better job than many cars produced, and proudly produced, by people who regard Ford as a joke.

(To be continued.)

USING SEA POWER.

The question of utilising the power of the tides is apparently going to be solved satisfactorily in the near future. As a matter of fact, a committee to study and investigate the problem has been formed by M. Jules Cels, sub Secretary of State for Public Works and Transports. As their researches have already proved very satisfactory, M. Cels has now decided to make special experiments and tests with a view to prompt realisation of the scheme. The experiments are being conducted partly at Finisterre and partly in the Bay of Saint Brieuc.

FIRST AMERICAN NATIONAL POST-WAR MOTOR SHOW HELD IN NEW YORK.

Tendencies of Change in Design.

The twentieth national automobile show to be held in the United States, opened at the Grand Central Palace in New York City, on Saturday, January 3rd, 1920. The crowds that thronged the Palace, morning, afternoon, and night, until the close of the show on January 10th, indicated the widespread interest in motor cars that is responsible for the present world shortage in automobiles.

The products of 84 manufacturers were represented in the hundreds of models that filled three of the great floors of the show. Another floor was given over to accessories and to farm tractors and other automotive products.

Motor trucks were exhibited separately in a large armory, where there was room for a full display. Seventy different lines were each represented by several different trucks of varied capacity. A feature of the truck show was the large attendance of experts on motor transportation. Daily meetings were held, experiences exchanged, and important points in regard to all phases of motor transport thoroughly discussed.

Naturally, the greatest popular attention was given to the show of passenger cars. The Palace presented a beautiful sight, decorated with garlands of smilax and greens. Each exhibitor's booth was enclosed by a white railing supported by white posts capped with brown. An usually artistic touch was given the display by tapestry panels placed at regular intervals along the walls; each panel depicted a scene in country life, and bore the coat-of-arms and name of the nearest exhibitor.

Upon entering the Palace, the first cars met with were the Buick and Chevrolet, which were assigned first choice of positions, as, in the order named, they led all exhibitors in the value of productian in 1919. Total production of passenger cars in the United States for the year 1919 was 1,891,929 cars, with a wholesale value of 1,399,282,995 dollars. This is a somewhat smaller number of cars than were built in 1918, though the value is considerably more. Total motor truck production for the year was 305,142, the greatest ever recorded.

One of the significant things to be remarked at the show was the care given to properly receive visitors from overseas. At the suggestion of the General Motors Export Co., which had a booth of its own at the 1919 show, 18 manufacturers co-operated in occupying a large export booth this year. Representatives of all these cars were present to give full information regarding the export models, and the placing of overseas orders. This feature was much appreciated by the many motor car dealers who attended the show from abroad.

Nothing radical nor bizarre was observed in the changes in design over the 1919 models. Whatever improvements have been made are along the lines of increased utility and more pleasing appearance. The many minor mechanical alterations noticed will add to the convenience and simplicity of operation, as well as making for economical performance by cutting down surplus weight.

The greatest attention has been given to body

design, to engines, and to chassis detail, while clutches, transmissions, and steering gears, already highly developed, reveal but slight changes. For the most part designers have held to the basic body lines shown last year. More overhead valve engines appeared than ever before, while the cars which have been using this highly efficient type have been improved, especially in lubrication. The six-cylinder car has increased its lead, being 55·8 per cent of the total of fours, sixes, eights, and twelves.

The following half-dozen instances, representing the various price classes, are typical of the models shown by the leading manufacturers, and illustrate the principal changes in design over last years cars.

The Cadillac, a high-grade eight-cylinder car, with an established world wide reputation, presented a new model, type 59. With this car, the Cadillac company completes its sixth year of eight cylinder production with more than 80,000 eight-cylinder cars on the road. The new model shows several refinements of substantial Cadillac features. There are 10 body styles in the 1920 line, four of which were exhibited at the show. The touring car has been lengthened, and placed on a 132 in. wheelbase, eliminating body over-hang at the rear and providing a roomy rear compartment. There was also shown a four-passenger phæton and two enclosed models, including a four-passenger victoria and town brougham, on custom-built lines without the roof over the driver's seat. A complete Cadillac engine, finished in nickel, and running by electricity, attracted a throng of mechanical enthusiasts, admirers of that scientifically-built machine, the measurements of which are accurate to the ten-thousandth of an inch.

The Buick, a famous valve-in-head six, and the produce of the world's largest builders of six cylinder automobiles, was represented by a chassis finished in brown, with nickled moving parts and springs; a two-passenger roadster; a five passenger and a seven-passenger touring car; and a sedan. Chassis changes include the removal of the speedometer from the front axle and wheel to the transmission, and the working out of a different spring suspension for all models to ensure the best possible riding qualities. The enclosed models are lower and correspondingly more graceful than the previous type, without sacrificing interior head room. All solid wooden frames are covered entirely with aluminium. The doors are of heavier construction, square pattern, and somewhat wider. The seats and cushions have been lowered and rearranged to give greater riding comfort, and the cowl has been redesigned to accommodate pilot side lights. Other minor refinements show similar close attention to detail.

The Oldsmobile, one of the pioneer cars, and now in its twenty-second year, exhibited three models of each of its eight and six-cylinder types. In the eights were included a four-passenger semi-sport model, the Pacemaker, and a seven-passenger touring, the Thorobred. A sedan and a stripped chassis were also among the eight-cylinder exhibits. The sixes shown included a five-passenger touring, and two closed models, a coupe and a sedan. One of the features of the Oldsmobile chassis is the extreme length of the semi-elliptic rear springs, exactly 56 in.; this permits great flexibility of suspension, resulting in the passenger experiencing a delightful cushioning effect when riding over even very poor roads. The eight-cylinder engine, built in V style, contains many original detail refinements.

The Oakland, a light-weight and low-priced six, exhibited a chassis and four body types, a five-passenger touring, a two-passenger roadster, and two enclosed models, a coupe and sedan. The engine on the stripped chassis was entirely exposed, and, operated by electricity, attracted many onlookers. Small electric lights flashed intermittently to indicate the firing order. The wheelbase of the new model chassis measures 115 in., an increase of 3 in. over the length of the previous type, while the frame has a depth of 6½ in. compared to the 4½ in. channel section of last season's car. Changes have been made in the rear spring suspensions which gives improved riding qualities, and the rocker shafts of the braking system have been rearranged to better equalise the action of the brakes. Announcement was made that 100,000 Oaklands would be built during 1920, of which a considerable percentage would be available for export.

The Scripps-Booth, a car formerly built in fours, sixes, and eights, is now produced only in sixes. This car, long noted for its unusual and pleasing design, has been entirely rebuilt, and is even more beautiful in appearance than the former models. The radiator is flat and nickel-plated, and the hood long, streamlined, and with many louvres. The wheelbase has been lengthened to 115 in. The engine is a six-cylinder valve-in-head type, of European small bore, high-speed design, simple in construction, and easily accessible. The models shown included, besides a stripped chassis, a three-passenger roadster, a five-passenger touring, a four-passenger Sedan, and a five-passenger Sedan.

The Chevrolet, a low-priced four-cylinder car of the valve-in-head type, built at the rate of 1,000 a day at the eight great Chevrolet factories, and especially designed for economical transportation, showed a number of refinements in the models exhibited. The fenders have been rounded to more closely follow the curve of the wheel. Other minor improvements have been made that add to the attractiveness of appearance of the car. For instance, all models now have tops of pantosote with plate-glass windows in the rear. A new switch has been placed on the dashboard. The Chevrolet is built on two chassis, the 490 and the FB, the latter having an engine of longer stroke and the chassis also having a longer wheelbase, and other specifications different from the smaller model. The cars exhibited at the show included a five-passenger touring, a two-passenger roadster, and two closed cars, a two-passenger Coupe, and a five-passenger Sedan on the 490 chassis, and a roadster, a touring and four-passenger Coupe and five-passenger Sedan on the FB chassis.

Such are typical examples of changes over the 1919 models of American cars. It must be remembered that the 1919 American models were radically different from and far in advance of the European designs of the 1914 period which have prevailed up to the present season, because of the Continental manufacturers being engaged wholly in war production for the past five years. The 1920 American car, therefore, refined and improved to a high degree, is an ultra post-war car, a motor car that embodies the vital discoveries of science in motor transportation that have been gradually accumulating in the past decade.

Trade Items, Notes, &c.

Drawing Instruments.—We wonder if any of our readers who are concerned in the production of drawings or tracings ever stop to think of the qualities that are essential to the instruments they handle. Surely, the first is accuracy; the second, durability; the third, quality of material and finish; and the fourth, ease and adaptability in handling. We have received a catalogue of "The Standard" British Empire drawing instruments manufactured by Mr. H. Harling, 47, Finsbury Pavement, London, E.C. They are manufactured from hard-rolled nickel-silver pressings, actually machined to standard gauges. The construction is as light as possible to ensure the necessary stiffness and rigidity. Care has been taken in the construction and design of the head joints.

Developments in Machine Stoking.—The economic consumption of coal used for the production of steam is one of the most important factors in boiler engineering, and one which demands the most careful consideration. The burning of coal is simple and presents no difficulty, but the burning of the gas produced during the combustion of the coal is the source of trouble. There is usually a great deal of steam produced, which rises to the top of the chimney and tends to augment the apparent volume of smoke. In the United States enquiries have been in progress to find out if possible the best conditions under which coal can be burned. The results of these enquiries which were carried out by the U.S. Geological Survey can be summed up in a few words. Almost any kind of coal can be burnt in a way to get the most power out of it without smoke by using a chain grate, a continuous feed, a long brick arch and proper means of regulating the admission of air. The many details not intended to come within the scope of this article are dealt with in a catalogue recently issued by Messrs. Ed. Bennis and Co. Ltd., who will be glad to supply copies to those interested on application to Publicity Department, 28, Victoria Street, Westminster, London, S.W.1.

British Industrial "Safety First" Association.—What a long list we should have if we could hear of one-half the serious accidents which take place in our workshops all over the country in a single day. Conspicuous acts of gallantry, involving personal risk on the part of an employee, are sometimes never heard of, yet they occur very frequently. The above-named Association is out to prevent accidents, and, incidentally, to recognise these acts on the part of employees at the works, factories, or premises of a member of the Association. An award, consisting of a badge, with a silver medal appended, is granted. This scheme may be very instrumental in saving life, and membership should certainly be encouraged. Full particulars can be obtained from their Head Offices at 2 and 3, The Sanctuary, Westminster, London, S.W.1.

Patent Applications.

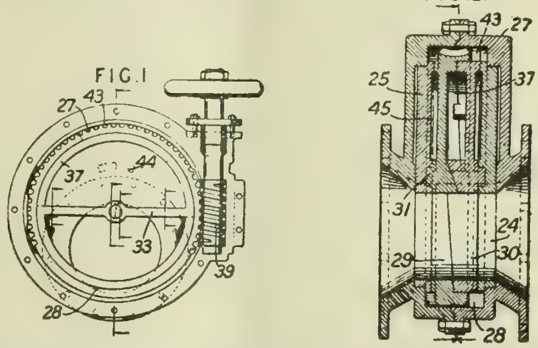
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

VALVES.

125,861.—C. H. Schmalz, Pompey's Pillar, Montana, U.S.A.—Aug. 16th, 1918.—A rotary disc valve actuated by toothed or worm gearing comprises a pair of valve discs pivoted eccentrically to the main passage way and provided with means for moving them to and from their seats. The valve discs 29, 30 have pivots 31 adapted to rotate in recesses formed in removable valve seats 25 and both valve members and seats are provided with ports 24,

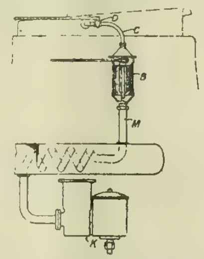
FIG.1. FIG.2.



the solid parts being recessed to facilitate machining. The back of each valve member is fitted with interengaging segmental cam surfaces 37 and with cross-bars 33 having twisted surfaces, the pitch of which increases towards the centre. The valve disc 30 has a stop 43 adapted to co-operate with stops 27, 28 on the casing and has a stop 45 to engage a stop 44 on the disc 29. The disc 29 has a flange embracing the disc 30 formed as a worm segment to engage an actuating worm 39 mounted in a side pocket of the casing. Spur or bevel gearing may be used to actuate the valve.

INTERNAL-COMBUSTION ENGINES.

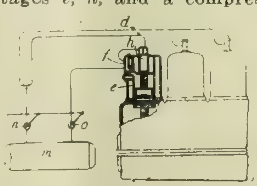
125,883.—E. B. Gilkes, 14, Gladstone Terrace, and F. G. Marshall, 56, Bewick Road, both in Gateshead-on-Tyne.—Oct. 12th, 1918.—Moist air is heated and admitted to the air admission pipe of a carburettor or is admitted unheated to the induction



pipe between the carburettor and vaporiser when the latter is employed. Air entering the pipe M through the lantern valve B receives water in drops from the pipe C, it is then heated in a coil in the exhaust pipe and passes to the air admission end of the carburettor K. The water cock D is worked by the throttle valve lever, the air valve B is adjusted independently.

INTERNAL-COMBUSTION ENGINES.

125,913.—B. E. D. Kilburn, 31, High Holborn, London (Sulzer Frères' Soc. Anon., Winterthur, Switzerland).—Dec. 20th, 1918.—In an engine to which fuel is injected by air under pressure from a stage compressor, a receiver f is provided between the high and low pressure stages e, h, and a compressed-air reservoir m



is connected through valves o, n to the receiver f and to the injection air pipe d. The valves o, u are so connected that, at starting, air from the reservoir m passes to the receiver f and thence to the injection pipe d, while during normal working, the reservoir is connected only to the pipe d in order to equalise the pressure of the injection air.

FURNACES.

125,987.—C. S. E. COSSEVIN, France.—April 22nd, 1919.—A grate for burning peat, household refuse, and poor combustibles in general is trough-shape in form and provided with hollow sectional inclined sides through which water circulates and a hollow bottom and back for the circulation of air, gases, or vapours to be consumed. As shown in Fig. 1, the sides of the grate are formed of partitioned sections 1 provided with inlet and outlet pipes for the circulation of water. Air and vapours drawn into

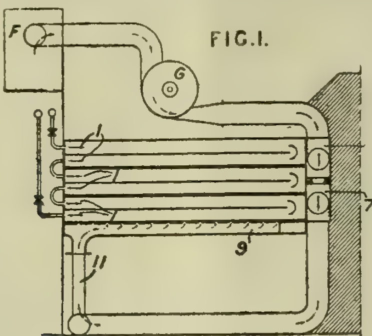
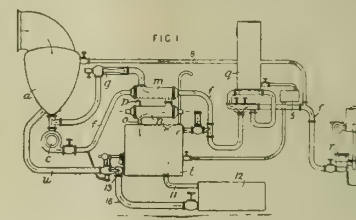


FIG.I.

the "smoke funnel" F are forced by a fan G through communicating chambers 6, 7 forming the back of the grate and thence through the pipe 11 to the hollow perforated bottom 9 of the grate. The chambers 6, 7 may be replaced by three superposed chambers of similar form to the sections 1. The bottom of the grate may be provided with pipes at the front for permitting the injection of vapour or gas. The bottom and other parts of the grate are independent and the bottom carries on its under face two pairs of wheels to permit it to be displaced readily.

CONDENSING STEAM; HEATING FEED-WATER.

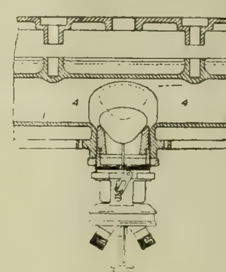
126,014.—G. AND J. WEIR, and W. WEIR, Holm Foundry, Cathcart, Glasgow.—Oct. 24th, 1916.—Relates to apparatus for condensing steam and heating boiler feed-water of the kind described in Specification 125,149 and comprising a condenser *a*, condensate pump *c*, steam-jet air-ejector *g*, surface feed heater *m*, feed tank *t* and a feed pump *r*, with, or without a main surface feed heater *q*. The invention consists in (1) using a combined feed heater *m* and condenser *n* such as described in Specification 15884/05, the residual air being discharged to the atmosphere through a pipe *p* and the condensate being led to the feed tank *t* through a pipe *o*; (2) providing a reserve feed tank 12 to which water overflows from the feed tank *t* through a pipe 11, and which communicates by a pipe 16 with the pipe *u* returning water to the condenser, a three-way cock 13 being fitted at the junction of these pipes in such manner that, under the control of a float in the feed tank *t*, it allows of the withdrawal of water from either of the tanks *t*, 12 upon the opening of the automatic valve *w*; (3) providing a filter 5 through which the condensate derived from the exhaust



steam used in the feed heater *q* is discharged into the feed tank *t*; and (4) providing a pipe 8 returning water to the condenser *a* from a point on the feed-pipe *f* between the heater *q* and the feed-pump *r*.

INTERNAL-COMBUSTION ENGINES.

126,037.—A. E. BERRIMAN, A. H. BUSH, and THE DAIMLER CO., all of Daimler Works, Coventry.—Nov. 4th, 1916.—The induction pipes of multicylinder V engines are provided with a longitudinal partition in order to separate the lateral branches leading to the



cylinders and thus prevent a piston that is moving quickly from withdrawing a charge from an opposite cylinder whose piston is nearly at the end of its stroke. The branch from the carburettor may be at the middle of the pipe 1 with a partition 4 on each side of it, or the carburettor may be at one end, the partition the same length as the pipe and provided with a port in the end remote from the carburettor. The pipes may be made of aluminium.

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CONTENTS.

EDITORIAL.

SOLID LUBRICANTS.

INFORMATION of the character exemplified in a recently issued Bulletin* is of the highest value. Although no research work has been done, and although it is pointed out that the present state of knowledge of the general question of lubrication is very incomplete, the Committee have collected the existing matter and have presented it in an able manner.

* Bulletin on Solid Lubricants, issued by the Advisory Council of the Department of Scientific and Industrial Research.

The various kinds of solid lubricant are referred to specifically. These consist of graphite, talc, soapstone, mica, flowers of sulphur, white lead, etc. Although lubrication may, broadly speaking, be said to consist in applying a film, more or less of a greasy nature, a solid lubricant does something more, or perhaps, it ought to be said, does it more completely. All surfaces are pitted, and the finely divided particles of lubricant associate themselves with one or other of the rubbing surfaces, filling in the pores and depressions and acting to some extent as a smoothing or polishing agent, covering the original surfaces with a thin smooth layer of the solid lubricant.

It is stated that a high degree of purity of the solid lubricant is necessary in connection with the lubrication of all high-class machinery, whereas, for rough bearings operating under extreme conditions, and on the verge of seizure, a small amount of impurities may not be detrimental.

Tests have been made with various types of solid lubricants, and the results are given. These are interesting, especially as a comparison table is given. The methods of applying solid lubricants may be divided into three: (*a*) dry application, (*b*) mixed with semi-solid lubricants, (*c*) mixed with liquid lubricants. Probably the most important part of the memorandum to the user is that devoted to the use of one of these three types to special machines. The method of application is also set out, and in the case of the last type, details in regard to mixing the solid lubricant with liquid lubricants are given.

Results obtained by the use of solid lubricants are noted. The experience of the individual user over a protracted period is undoubtedly valuable, and it is worthy of record that good results have been uniformly obtained. In one example given, heavy duty bearings, which previously gave trouble when heavy oils were used, were found to run cooler when graphite was employed. In this case, oil and graphite were used together. The reports in regard to carbon formation, and cooling of plugs in internal combustion engines, when solid lubricant is employed, are contradictory. As has been said earlier, this memorandum is not a report on actual research work done, but a collection of informative matter gleaned from many sources, chiefly actual experiences in the use of such a form of lubricant.

Even so, it is of considerable value, and adds to the technical literature on the subject.

WATER POWERS OF BRITISH COLUMBIA. A copy of the Canadian Commission of Conservation's publication, "Water Powers of British Columbia," published in 1919, may be consulted at the Enquiry Room of the Department of Overseas Trade, 35, Old Queen Street, S.W.1. It includes a review of water power legislation and a discussion of various matters respecting utilisation and conservation of inland waters.

MODERN MACHINE SHOP PRACTICE AND THE LIMIT GAUGE SYSTEM.

By M. CORONEL.

(*Continued from page 156.*)

THERE are a few more special fits, such as keyway fits and others for special purposes. Gauges take the following forms. Holes are measured by internal plug gauge (Fig. 2) for holes, say, from ½ in. to 8 in. diameter; for smaller holes, plate gauges (Fig. 7) are used; and for large bores, I. beam gauges (Fig. 2A) say from 6 in. to 16 in. or point gauges (Fig. 8) or internal limit rods (Fig. 10) are used.

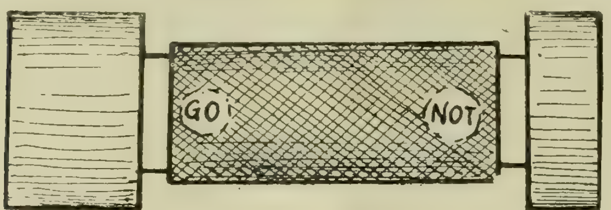


FIG. 2.—INTERNAL (PLUG) GAUGE.

For measuring shafts and pins, fixed caliper gauges (Fig. 3) are used for sizes, say, from ½ in. to 12 in. diameter; for smaller sizes, plate gauges are used (Fig. 6 and 6A); and for larger sizes, beam gauges (Fig. 11). For shaft sizes from ¼ in. to 3 in. the form, Fig. 5, is often used, and where not frequently used fits are required to be set as required, the adjustable caliper gauge (Fig. 4) is used.

To measure two parallel surfaces, plate gauge (Fig. 7) is used for small sizes, plug gauge (Fig. 2) for medium sizes, and for large distances the flat point gauge (Fig. 9) is used, width of keyways are measured with gauges, see Fig. 7A, the depth of the way with Fig. 7B. As will be seen, each gauge has a side marked "go" and one "not go" indicating

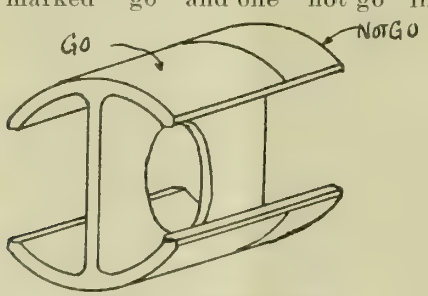


FIG. 2A.—I BEAM GAUGE.

the workable limits; only the point gauges (Fig. 8) and flat point gauges (Fig. 9) have no limits, and are measured by a travel or wobble within certain limits. The point gauge is made a minute amount smaller than the finished hole, and the travel thus obtained fixed within certain prearranged limits (see Fig. 12), for point gauges the wobble tolerance × √diameter, for flat point gauges the wobble ½ tolerance × √diameter. The same procedure obtains when measuring the distance between the two flat surfaces with the flat point gauge (Fig. 9). Gauges are checked and adjusted, caliper gauges (Fig. 4) are set to standard setting pieces, as shown in Figs. 13 to 15.

For measuring the exact sizes obtained by the limit system, and checking up parts to be replaced, micrometers of various shapes are used. Fig. 16 is used for shafts and flat surfaces. Fig. 17 for holes of moderate sizes. Figs. 18 to 20 for holes and distance between two flat surfaces of larger sizes. Fig. 21 is used for measuring the depth of holes, slots, etc.

(3) The essential parts of a machine having been made to the gauges, limits and fits mentioned above, it is evident that very little or no fitting is required in the erection of the machine, provided that the inspection department is an efficient one. The old-

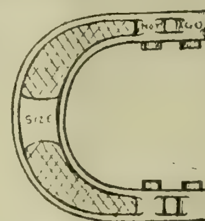


FIG. 3.—FIXED EXTERNAL (CALIPER) GAUGE.

time fitter, with file, scraper and emery paper, becomes then an assembler of parts and erector of machines. It will therefore be seen that a whole department is almost cut out, and a department where most of the time was generally spent in finishing the average machine.

(4) We now come to the fourth point on our programme, viz., the inspection. This is a most vital part of a modern machine shop, and the man in charge should be a very superior workman, and

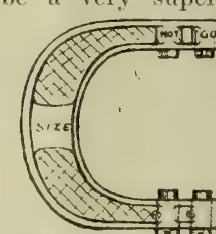


FIG. 4.—ADJUSTABLE EXTERNAL (CALIPER) GAUGE.

certainly in a large works a more skilled man than the foreman, and by his position and responsibility should be placed above the shop foreman, although not necessarily having a direct connection with him; as a matter of fact, the less the inspector has to do directly with the machine foreman the better for the efficiency of his department, as his job is solely to check and inspect the work coming to him from the various machines, and if correct the same is passed

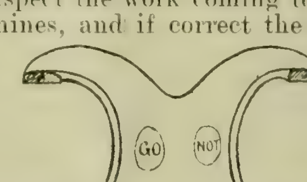


FIG. 5.—DOUBLE-ENDED FIXED EXTERNAL (CALIPER) GAUGE

on to the store or to be erected and assembled. If found to be incorrect, a label or note to the foreman should be attached to the defective part, stating (1) whether the part is still of use, if the mistake can be put right; (2) the discrepancy should be stated, and any further statement for the foreman's guidance made; a copy of the statement to be retained by the inspector, whose responsibility for the progress of that part ceases there, and the responsibility for any

delay on the part is with the foreman concerned. In many cases where the particular part is not made to the dimensions and fits stated on the drawing, the inspector by consulting the drawing office can arrive at some workable solution for utilising the part concerned, by either altering the part fitting to it or using it for a next order, and much scrapping can be avoided by a close working agreement between the

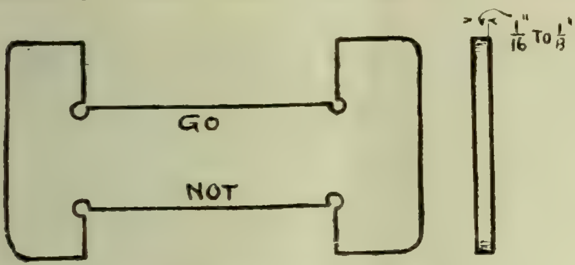


FIG. 6.—EXTERNAL PLATE GAUGE.

drawing office and the inspection department. The inspector, therefore, should be a man who, besides understanding his inspection pure and simple, possesses forethought, tact, and discrimination and independent judgment, as the rejection of machined parts is often apt to be looked upon by the foreman with bad feeling and disfavour, and unless tactfully handled, there appears very often a great amount of friction between him and the various fore-

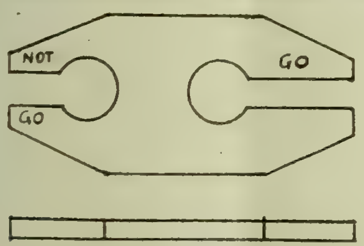


FIG. 6A.—PLATE CALIPER GAUGE.

men whom he appears to be criticising, although only doing his duty as an inspector. It very often appears, especially in new work, that the drawing office has not selected the right kind of fit, the running clearance for example, between a special shaft and bearing not being sufficient after the job is put to the test. It is then the inspector's place to report and consult the drawing office about the matter, and have similar drawings altered accordingly. After these

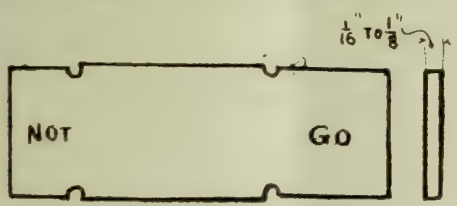


FIG. 7.—INTERNAL PLATE GAUGE.

preliminary remarks as to the duties of the inspection department, we proceed to describe the inspection proper. As stated before, after leaving the machines all machined parts should be sent into the inspection department, where the inspectors, by means of limit gauges, measuring machines, micrometers and testing machines, compare the parts with the drawings of same, which have been properly marked up with all the necessary limits and machining marks. There are various ways in which to mark the dimensions on the drawings with various limits. One of the most commonly used methods, however, is to put the class of fit required after the dimension. A shaft of 6 in. diameter to run in a bearing should be marked 6 in. diameter X if an easy running fit is required, or 6 in. diameter Z if a very close running fit is required. The bearing, however, in which this shaft runs should be marked 6 in. bore A, or 6 in. diameter A when working to very close limits, or 6 in. diameter B when working to coarser limits. The consequent clearance between a 6 in. diameter X shaft and 6 in. diameter A hole, would be from three to eight-thousandths of an inch. These limits, three to eight, represent the combined tolerance allowable between hole and shaft, due to inaccuracy of workmanship.

FIG. 7A.—KEYWAY WIDTH GAUGE.

From the above it will be seen that if parts of machines are made by the method indicated above various parts of machines can be made in half dozens at a time, at least the smaller parts, after being finished to be put into stock and taken from that stock whenever an order for such a machine is being received. This method shortens the time of delivery, and is sometimes a very vital point in securing an order of urgency, and cheapens cost of production. The author knows of a case being thus put to the test by an engine works in this town, where the order was received in the evening for a 150 B.H.P. multiple-cylinder engine, and kept back till the following morning. When the works started the order was issued, parts of the engine were taken from stock, assembled, erected on test plate, and by the evening of the same day the engine was running

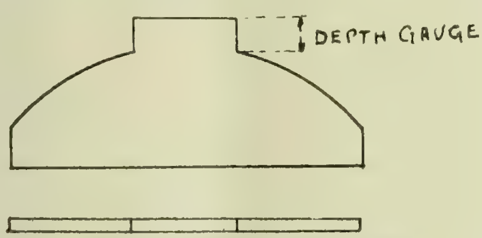


FIG. 7B.—KEYWAY DEPTH GAUGE.

on a 24 hours' continuous test. This was certainly an exceptional performance, but at the time it was claimed by the firm they could do so over and over again. Still it shows what can be done by interchangeability and accuracy in machining. All parts should be marked with a distinctive mark, and a full list of these marks and a description of the parts they represent should be sent with the shipping list of the machine, so that if any part requires replacing it is only necessary to quote the mark of the particular part, and an exact duplicate can be sent by return. This is especially of advantage for overseas shipments to out-of-the-way places where one could not get local replacements, and saves a great deal of travelling expenses of engineers and representatives.

(To be continued.)

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(Continued from page 138.)

Radiation Pyrometers.

The subject of pyrometry owes much to Charles Féry, who commenced a study of the radiation from heated bodies about 1900. His first experiments were concerned with the temperature of the mantles used in incandescent gas lighting, and he invented a thermo-electric radiation pyrometer, in which he applies the law of Stefan. In his first instrument he concentrated the radiation by a lens, made of the mineral fluorite, on a thermo-junction which was connected to a calibrated galvanometer. Owing to the uncertainty of the connection that must be applied for the absorption of the radiant heat by the lens, he modified his instrument to the design shown in Fig. 1. A concave mirror of special glass is gilded by the hot process, which gave a thin adherent layer of metal able to resist oxidation, and having a reflecting power of 93 per cent of that of polished silver. The rays A from, say, a furnace, are received on the concave mirror C, and concentrated to a focus at N. Through an eyepiece E, the observer can see the image of the hot part of the furnace on a small mirror M in which there is a small central opening.

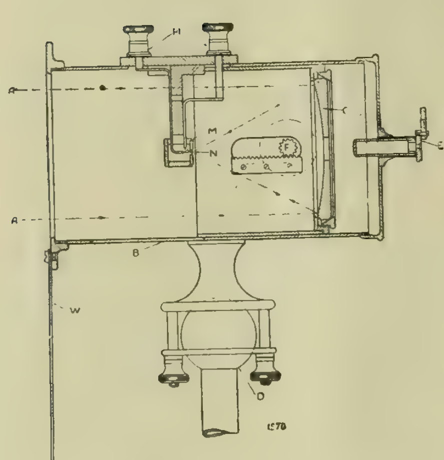


Fig. 1.—Féry Pyrometer (The Cambridge Scientific Instrument Co).

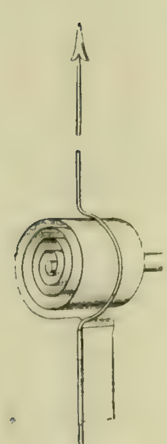


Fig. 2.—Spiral Indicator (The Cambridge Scientific Instrument Co.)

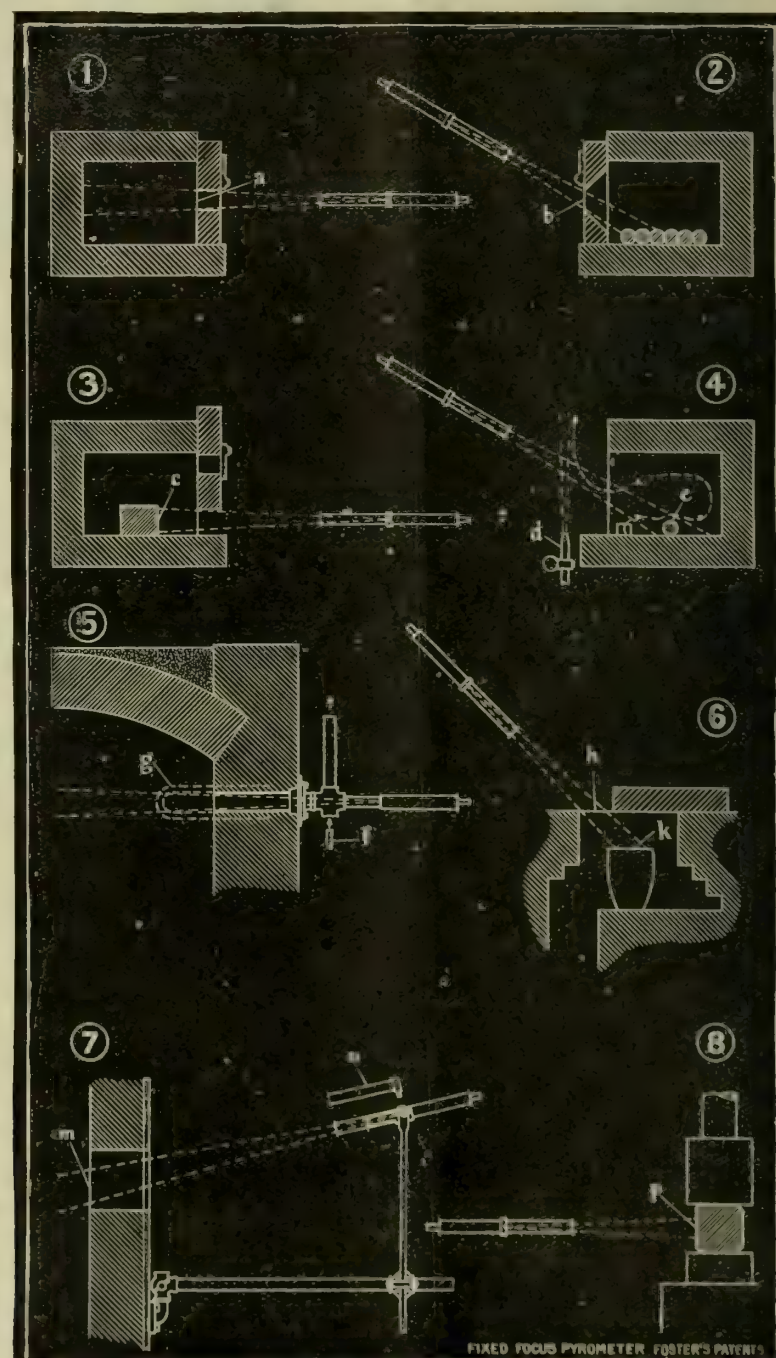


Fig. 4.—Various Uses of the Foster Pyrometer.

Immediately behind this hole is the small thermo-junction. The small mirror actually consists of two semi-circular reflectors which are wedge shaped. This dual reflector is of great assistance in accurately focussing. When the milled head is rotated, the concave mirror can be moved to and fro. If the rays correctly fall on the junction, the observer will see the two semi-circles fitting exactly over each other, otherwise they are seen as if laterally displaced. The thermo-junction is connected by the terminals *a* and *b* to a suitable table galvanometer. For the convenience of directing the opening of the pyrometer in any required direction, the instrument is supported on a tripod, having a ball and socket joint at O.

The size of the body or opening sighted, and the distance of the instrument from the hot source, do not effect the accuracy of the readings providing that the image of the distant object overlaps the thermo-junction on all sides. The thermo-element, it must be understood, does not measure the total radiant energy reflected, but the intensity of the heat image. This intensity is independent, within certain limits, of the distance. Thus, if the distance is doubled, the

Fig. 3.—Fixed Focus Pyrometer Outfit (The Foster Instrument Co.).

total amount of heat received is reduced to one-fourth, but the area of the image is also reduced by the same amount, so that the actual heat intensity remains unaltered. The instrument, as made by the Cambridge Instrument Co., requires that for every two feet that the instrument is distant from the hot source, the latter must be at least one inch in diameter. The indicator may be calibrated for one of the following ranges, 500–1100, 600–1400, and 800–1700° C. To assist in the choice of the scale, the following approximate values of temperatures will be useful:—

Hardening high-speed steels	1100–1500° C.
Case-hardening furnaces	850–1000° C.
Malleable iron furnaces	950–1050° C.
Annealing steel castings	900–1000° C.
Open-hearth steel furnaces	1600–1700° C.
Glass melting furnaces	1200–1500° C.
Gas retorts	900–1250° C.

Féry simplified the pyrometer by dispensing with the thermo-junction and galvanometer, and substituting a bimetallic spiral (see Fig. 2). It is made of two metals, having different co-efficients, of expansion fixed together. The dimensions of the spiral are very small, being less than $\frac{1}{8}$ in. in diameter and $\frac{5}{64}$ in. wide. Its centre is fixed, and the free end carries a light aluminium pointer which indicates temperature on a circular scale fitted round the tube of the pyrometer. This spiral is blackened, and receives the radiant heat reflected from the concave mirror. As the temperature of the spiral rises, it uncoils and rotates the pointer over the scale. This spiral type is cheaper than the thermo-electric instrument, but in accuracy it is inferior.

Pyrometers with Fixed Focus.

The Foster Instrument Co., of Letchworth, have introduced a fixed focus radiometer pyrometer, which can be held in the hand and directed to the source of heat without the necessity of any focussing device. Fig. 3 shows the standard outfit, about one-eighth full size. The receiving tube, containing a concave mirror and thermo-junction, is connected by flexible leads with a portable indicator directly graduated with a temperature scale. The operation of the instrument is independent of its distance from the source of heat, within the limits of the rule:—

"The maximum working distance must not exceed the diameter of the hot body multiplied by a *distance factor*." The range and distance factor for the standard outfit is shown below:—

Range ° C.		Distance Factor.
500–1000	...	10
700–1400	...	10
800–1600	...	10
900–1800	...	12

Thus if a pyrometer of range 700–1400° C. be in use in finding the temperature of a bar of steel 6 inches in diameter, then the distance from the centre ring of the instrument to the steel rod must not exceed $6 \times 10 = 60$ inches. Fig. 4 shows various applications of the pyrometer.

1. The general temperature of a furnace is being measured in which the actual radiating surface is the back wall of the furnace. To find the working distance measure from *a*, the inner edge of its peep-hole.

2. The temperature of the floor, or objects on it is being measured. The hole *b* must be conical, so as not to impede the radiation.

3. The block *c* in the furnace is observed by raising the furnace door a few inches. Measurements to be made from *c*.

4. In finding the temperature of a small body *c* on the floor of the furnace, the floor of the furnace and the body must be brought to the same temperature as judged by the eye. If the furnace is under air blast a "cross blast" should be used to blow aside any flames. This may me done by coupling-up a $\frac{1}{4}$ in. gas pipe *d* to the air supply.

5. This shows the case where a large permanent opening cannot be used. The pyrometer tube is of special construction, and is fixed to the furnace wall by a flanged fitting and a cross ventilation device is used. This can be supplied, if necessary, with air under pressure by the $\frac{1}{2}$ in. pipe *f*.

When not convenient to use a cross blast, a refractory tube *g* closed at the inner end should be used. This tube attains the furnace temperature and acts as the radiating body.

6. Here the temperature inside a crucible is being measured. The working distance is measured from *h*.

7. The pyrometer tube is supported by an adjust-

able bracket and cradle, the working distance being measured from *m*. To avoid any doubt as to the actual direction of pointing, the sighting tube *n* may be used which is first placed in the cradle instead of the pyrometer tube. The latter is replaced when the desired pointing has been fixed.

8. In measurement of the temperature of metal during forging or rolling, the working distance is taken from *p*. It may be convenient to support the pyrometer on a tripod. The object not being an absolutely black body, the indicator must be specially calibrated for the purpose of measurements of this kind. (*To be continued.*)

NOVELTIES TO BE SEEN AT THE GREAT MOTOR-BOAT AND MARINE ENGINE EXHIBITION.

All lovers of the sea and river—and what true Britisher is not?—will find many attractions at the forthcoming International Motor-Boat and Marine and Stationary Engine Exhibition, which will be held at Olympia from March 12th to 20th, under the auspices of the Society of Motor Manufacturers and Traders Ltd., in collaboration with the Ship and Boat Builders' Association Ltd. and the British Electrical and Allied Manufacturers' Association.

It will be a striking revelation to those who have not followed the remarkable development of the internal combustion engine as applied to river and sea-going craft. It will also be a great educational force, and will not only interest adults, but the younger generation also will be greatly attracted by the wonderful working models of the boats, etc., which, in the tanks, will demonstrate their practicability.

The river enthusiast will be delighted by the very fine specimens of the boat-builders' art, from canoes to luxurious river launches, with every refinement possible, and built on motor-carriage lines.

Those engaged in the great fishing industry will find distinct evidence of the advantages of the internal combustion engine for coastal work and for trawlers; while the passenger and cargo-boat section will show to all interested how the big oil engine is displacing steam.

Among the countries represented will be Great Britain, France, Sweden, Denmark, U.S.A., etc., filling the whole ground floor of the great building with their exhibits.

The internal combustion engines will range from 2 h.p. to 500 h.p., from the single-cylinder to the 18-cylinder class: from the small auxiliary motor to the big oil engine. In fact the Exhibition will be a veritable triumph for the internal combustion engine, for the very latest specimens of engineering will be revealed in engines for compulsion, lighting and power, proof of which will be further increased by the working engine exhibits.

The exhibits will include motor lifeboats passed by the Board of Trade as part of liner's life-saving equipment, and fitted with wireless installation; seamless steel motor lifeboats, canoes, dingheys, river launches, etc., while the "knock-down" system of boat-building will create a sensation, and should largely solve the problem of boat shortage.

These "knock-down" boats consist of frames which have been previously erected and fitted, after which each part is taken down and packed in a very small compass and crated for shipment to any part of the world; all that is left for the purchaser to do being to reassemble the parts and planking, which latter is also supplied ready sawn and cut to shape. By this system boats can be supplied to builders and amateurs at considerable less cost than would be possible if each boat were designed separately. One firm has no less than forty designs, ranging from an 18-ft. launch to a 65-ft. cabin cruiser or freight boat; and proof of their real utility is demonstrated by the fact that they are doing splendid service in India, Australia, and other parts of the globe where the services of naval architects, designers, and skilled boatbuilders are not available. A new system of skiff-building will be shown on this "knock-down" principle, and the firm undertakes to teach any handyman to build a boat.

Inventions to protect iron and steel from corrosion, safety devices to prevent explosions in petrol tanks, electric motor windlasses, steering gears, oil engine starting lamps, propellers, pumps, instruments, lubricators, magnetos, couplings, gauges, sparking plugs, cabin furniture, and a thousand and one accessories, will indicate the great industry which has followed in the wake of the internal combustion engine.

The great advance made in electric lighting installation will be manifest; not only will there be equipment for all kinds of craft, but installations for the home will be on view. Certainly all who contemplate adopting electric light will do well to visit this Exhibition, and see for themselves the great strides which have been made in this direction.

The Exhibition will be open from 11 a.m. to 9 p.m. each day. The admission is 2s. 6d., including tax, excepting on Thursday, March 18th, when it will be 5s. up to 6 p.m. Popular catering will be carried out by Messrs. J. Lyons and Co. Ltd., and the band of H.M. Royal Marines has been engaged.

Packing of Machinery for South America.—A mechanical engineer, with many years of experience on the West Coast of South America, has given H.M. Commercial Secretary at Lima the following note on the packing of machinery, particularly electrical machinery, for South America: "All engineering plant should be packed in strong, braced, open cradles of deal, and these cradles should again be packed in a heavy deal packing case, fitted with battens and, if possible, with diagonal braces. Machines must, under no circumstances, be bolted down to one side of the case. There is no objection, however, if the opposite side of the machine is bolted to the case, too. It is much better, however, to pack the goods in a cradle and to make the cradle fit the case exactly, so that, even if the case is dropped, the stress is distributed equally all over the case, and not on any one side or end. All such small fittings and projections as handles, levers, valves, pressure gauges, etc., should be detached and packed tightly with wood wool into a small strong wooden box, firmly screwed on to the inside of the main case or cradle. Any moving parts (as armatures of electric motors) must be wedged tight relatively to the fixed portion, to prevent oil rings being sheared off, bearing shields broken, and other damage occurring. Any case containing machinery should be capable of being dropped fifteen times from a height of one metre on to a concrete floor without injury to case or contents. This represents the average history of a case of machinery leaving the United Kingdom or America, and arriving on site at final destination. So few breakages have occurred with this system of packing over a very large number of consignments that insurance against it is not really necessary. The cost of the packing is 30 per cent above that of ordinary heavy cases." A sketch illustrative of the above instruction may be seen on application to the Latin America Section of the Department of Overseas Trade.—*Board of Trade Journal.*

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 183.*)

This completes the study of the reactions and stresses in the bodies of plate springs, and there now remains only one more thing to be considered, in this paper, and that is the

Separation of Loads in the Top Compound Plate.

It has previously been mentioned that when the "full length" plates are not tapered at all, they may, for primary purposes, be considered as equivalent to a single plate with a moment of inertia equal

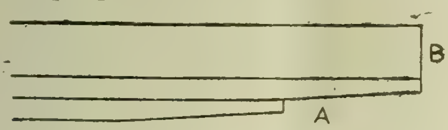


Plate Springs.—Fig. 30.

to the sum of the moments of inertia of the separate plates; then, after the final reaction has been found, it is evident that the various plates making the compound top plate will each support a portion of the load in direct proportion to its own moment of inertia. In this case, after finding the final load on the end of the spring, it is only necessary to divide this load in the ratios of the moments of inertia of the plates of the compound top plate, and the loads on the separate plates are at once determined. An example of this was given in our illustration for the No. 6 point.

In actual springs it will be found, however, that the lowest of the long plates is generally tapered, and in this case a special investigation is necessary in order to separate the loads on the various plates, which have the same length.

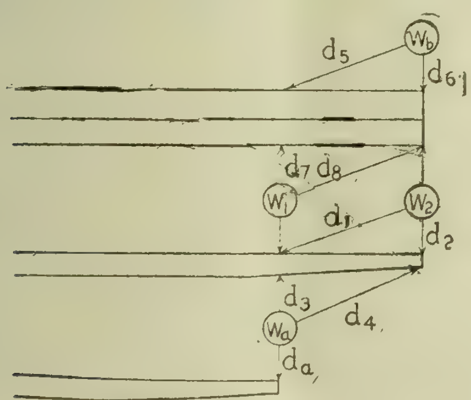


Plate Springs.—Fig. 31.

The full length plates, including the main plate, which are not tapered, may be, for the primary calculation, considered as one plate with a moment of inertia equal to the sum of the moments of inertia of these plates, and the total load may afterwards be divided between them in the direct ratio of their moments of inertia, in the same manner as before. We may therefore consider the compound top plate to be made up to one tapered and one plain end plate, as shown in Fig. 30.

The various deflection coefficients which will be required in the analysis are shown in Figs. 30 and 31, in which it is to be understood that for the tapered plate:—

W_2 produces a deflection d_1 at A and d_2 at B

$Wa - W_1$ produces a deflection d_3 at A and d_4 at B;

for the plain plate or plates:—

$Wb - W_2$ produces a deflection d_5 at A and d_6 at B

W_1 produces a deflection d_7 at A and d_8 at B

and for the spring W produces a deflection d at B.

A consideration of the deflections shows that:—

$$d_1 - d_2 = d_a \text{ (which is known)}$$
$$d_2 - d_4 = db$$
$$d_5 - d_7 = da$$
$$d_6 - d_8 = db$$

Now let

$$d_1 = k_1 W_2,\ d_2 = k_2 W_2,\ d_3 = k_3(Wa - W_1),\ d_4 = k_4(Wa - W_1),\ d_5 = k_5(Wb - W_2),\ d_6 = k_6(Wb - W_2),\ d_7 = k_7 W_1, \text{ and } d_8 = k_8 W_1$$

Then, inserting these values in the above equations and solving in the usual manner, it will be found that:—

$$\frac{W_1}{W_2(k_1k_4k_5 - k_2k_3k_5) + da(k_1k_6 - k_2k_5)}$$
$$= \frac{-W_2}{Wa(k_3k_6k_7 - k_3k_5k_8) + d_a(k_3k_6 + k_6k_7 - k_4k_5 - k_5k_8)}$$
$$= \frac{Wb}{W_a(k_1k_4k_7 + k_3k_5k_8 - k_2k_3k_7 - k_3k_6k_7) + da(k_4k_5 + k_5k_8 - k_2k_7 - k_6k_7)}$$
$$= \frac{-db}{W_a(k_1k_4k_5k_8 + k_2k_3k_6k_7 - k_1k_4k_6k_7 - k_2k_3k_{58} + k\ da(k_2k_3k_6 + k_2k_6k_7 - k_1k_4k_6 - k_2k_5k_8)}$$
$$= \frac{1}{k_1k_4k_5 + k_1k_5k_8 - k_1k_6k_7 - k_2k_3k_5} \quad \ldots\ldots\ldots\ldots (54)$$

which determines W_1, W_2, Wb and db.

The k's for use in the above equation are to be calculated in exactly the same manner as the A's of the earlier illustrations; there is no real difficulty, but there *is* a great amount of arithmetical work. The substitution of numerical values into the expressions given above offers no new features of interest, and there does not appear to be any necessity to give an example.

This concludes the analysis of reactions and stresses in plate springs as actually manufactured; the third paper will consider the internal stresses due to the "nip" produced in manufacturing and also the effect of the variation of the stresses on the life of a spring.

(*To be continued.*)

Tenders Invited for Electrical Plant in South Africa.—The office of His Majesty's Trade Commissioner at Cape Town has notified the Department of Overseas Trade that the Oudtshoorn Municipality invite tenders for the supply of the following electrical plant: Complete Locomotive type Steam Set, with Generator and Switchboard, or alternatively: (*a*) Boiler and Auxiliaries, (*b*) Steam Set with Generator, (*c*) Condenser and Auxiliaries, (*d*) Switchboard. Tenders, which should be sealed, and endorsed on envelope "Tenders for Electrical Plant," and addressed to the Town Clerk, Town Office, Oudtshoorn, will be received there up to the 24th March 1920. Copy of specifications and full particulars may be obtained from the Municipal Electrical Engineer, Box 132, Oudtshoorn, C.P. A copy of the specification and blue prints, may be consulted by British firms interested at the Enquiry Room, Department of Overseas Trade, (Development and Intelligence), 35, Old Queen Street, S.W.1.

CAR DESIGN AND CAR USAGE.

By Edgar N. Duffield.

(*Concluded from page 196.*)

The author would very much like to see some of our suspension experts try an intelligent application of Ford suspension to their own chassis. It works so well on the Ford that it might well prove perfectly practicable to modify it in such wise as to work satisfactorily on cars with greater running weight and less ground clearance. The B.S.A. car, as built up to the time of the war, showed a very creditable piece of suspension design, though distinctly complimentary, to say no more, to the designer of the Ford car. The suspension of the Marmon is very efficient, but to the author's mind no more so than that of his favourite semi-elliptic springs intelligently applied and adequately protected.

Now let us look at the woes of the designer. His main handicaps are his own knowledge and common sense. His knowledge prevents his visualising the ignorance of the average representative user of cars. His common sense makes him say, "surely the most ignorant person will have sufficient 'savvy' to avoid trouble there!" He must recognise, however, that the majority of users of cars (whose vagaries must, in the ultimate resource, control design, let us agree) know nothing *and care less* of mechanics or physics. They regard their cars simply as vehicles, the use of which will call for no more care than is demanded in using railroad trains. Moreover, the designer must remember that cars are still being newly—by which is meant for the first time—taken into service by old and crusted horse users, who will treat £1,000 cars with a lack of loving-kindness they would never dream of applying to a £100 horse.

The designer who recognises that classic virtue, "fewness of bits," will emancipate us, free us from the thraldom of things like water pumps and complicated fuel feed systems. If he will apply his physics to things like water cooling and fuel feed, he will save ourselves (speaking as users) and himself lots of heart burnings.

The Ford car, ever present in the author's mind because of its "pervadingness," which springs from its serviceability, is anything but well designed in a number of details. It has won its position in the world's markets simply because it can be kept serviceable with very little cajolery or nursing. It is more uncommon to see a Ford car "stuck" than any other make of car, even with tyre trouble, although the Fords in use here must enormously outnumber cars of any other one firm's construction. It succeeds in the hands of foolish, ignorant and careless users, simply because its necessary, essential adjustments and lubrication could not well be reduced in number or in frequency. There is one side of the picture. Now for the other—furnished by the reminder that a special tool has to be made or bought to open the oil-level cock on its crank-case, unless the owner is willing to crawl under it! The Ford, we see, is not perfect. Let us all take hope from that fact. But it is a success, not primarily because of its low price, but because it was built to withstand the handling, or rather mishandling, of people mechanically unequal to fitting a new washer on their bathroom taps.

Cars of the future must be designed upon the hypothesis, if not the moral certainty, that short only of wilful destructiveness their users will do to them everything they should not, or will *not* do to them anything that they should. There will, of course, always be a demand for the refined, complex car, ready to yield an extreme degree of driving pleasure to users who correspond, among motorists, to those who will only drive or ride thoroughbred horses. But this demand will never, or at any rate not for years to come, be very great as compared with that for inexpensively bought and inexpensively run cars, light as to weight, simple as to design and construction, and yet of high service capacity.

Therefore the young designer has to elect whether to work for the Rolls-Royce or Ford section of the market, in so doing remembering that there will be for a long while ever so many more Fords than Rolls-Royces required.

Cars have progressed marvellously in performance capacity, but hardly at all in maintenance simplicity. Design has been directed 70 per cent in the one direction to 30 per cent in the other. This is natural, because there is undoubted attraction about art with a capital A, even in the wielding of metals. But if all our embryonic designers are to live and die as designers, at more than mechanics' earnings, they must—as to at least the majority of them—readjust the proportions, and attach quite as much importance to maintenance simplicity (which makes for increasing service capacity, by the way) as to performance efficiency in the direction of "super" degrees of power, balance and general engineering refinement.

It occurs to the author now that this paper will be more than a little disappointing to those who came here with the idea of learning anything new. But if only one of the younger members will go away determined to give us a far, far simpler car than any we have had before, he will be well repaid for his endeavours.

If he were drawing up a specification for a 1920 car, he would make great play with HL 8—that most serviceable aluminium alloy which enters so largely into aeromotor construction—and also utilise stampings and die castings in numbers and of sizes that would shock the older school of design. The main frame would incorporate—or, to put it more clearly, be integral with—a revolutionary number and variety of other things, because in existing cars there is, to the author's mind, undesirable inequality of robustness—uneven strength, and too varying degree of elasticity, about the chassis as a whole. He would, of course, use overhead valves on the engine (if the price of the job precluded the use of one of those excellent single sleeve valve engines), and the more closely the engine resembled an oblong block of aluminium, the better he would be pleased with it. He would like it to be so "plain" and "smooth" that it would pass muster without a bonnet, and would suffer no harm by running naked.

The gear-box would be small, but the pinions would be large, of unusual depth or width of tooth, every one of them would be spirally or helically hobbed, and the shafts carrying them would be unusually stubby, and carried in roller bearings. The pinions would be ground after hardening, and when the direct-driven top-speed combination was engaged there would be no

idle pinions rotating. Three forward speed combinations would be enough, the engine being really flexible and as steady in its work at 300 as at 3,000 revolutions per minute.

Oil would be used as a lubricant everywhere, yet there would never be pools of oil on the road where the car had halted, or on the motor house floor. Leaks of oil became unnecessary six or seven years back.

Disk wheels would be used, with detachable flanges to permit the really easy replacement of damaged tyres, so that the driver need never injure his finger nails (much less those nice shiny tyre levers of soft iron) in changing tyres.

The radiator would be really large enough for its work, even with a following wind all day up a 1-in-10 average road—if, that is, it could not be demonstrated at least to the author's own satisfaction that water cooling was out of date. In this connection he might predict that inside five years, or at most ten, the engines of nearly all cars will probably be built up of steel liners, shrunk into aluminium cylinders proper, the outer surfaces being well finned and then heavily coated (by electrical deposition) with bright copper. Air cooling is on the way.

Improved ground clearance, and the abandonment of an oil pan or undershield beneath an HL 8 base chamber, *plus* a good system of forced air draught, will very shortly be found capable of giving the engine just as ample air cooling as that enjoyed by aircraft engines.

The engine would, of course, be entirely lubricated through one oil filler, the gear-box, transmission joints and rear axle through another, the clutch through a third, the steering (in its entirety) through a fourth, the wheel bearings through another four, and the springs through another four. A dozen oiling points, and a monthly replenishment of the reservoirs, would serve for every month the car was driven 1,000 miles—a fair mileage for the average "private" owner.

Yes; the author has his personal ideas upon design, upon the design of almost all the components of a car. But such ideas are so purely personal, so essentially individual, that he regards them as of neither importance nor interest save to himself and a few friends toiling with him.

Far more vital to him is a statement of what we want, of where we want to get, if we are to supply British car buyers in future. The most popular car of the future will be that which is lightest, has fewest individual parts, and is most easily kept in really good running order. For one car bought by a man who enjoys adjusting, cleaning and lubricating it, there are at least a thousand bought by others, and their £1 notes will buy just the same 5s. worth of food, raiment and so forth, for designers, as will those of the man who buys a car to tinker with it. The majority buy to-day, and will as an ever increasing majority buy in the future, to get a dependable means of road transport.

Some day or other, some designer or other, working in some country or other—and the author hopes it may be ours—will give us the ideal car for the multitude. This will sell for the current price of the Ford of that date. But it will be handsomer than the Ford, lighter, faster, able to carry more weight on less fuel and lubricant than the Ford, with less tyre wear than the Ford. On top of all this, it will be a car which can be adjusted, cleaned, filled up and lubricated, and altogether kept in absolutely first-class trim by a British maiden of seventeen, habitually garbed in cream serge coats and skirts, and addicted to white shoes and stockings and white wash-leather gloves.

The goal of the designer must be that the aforesaid British maiden shall be able to do everything that has to be done in, on or about the car (short of an annual overhaul, which, by the way, will cost £5 for labour *and* replacement parts) without besmirching her toilette or soiling her hands.

He has a long way to travel, and the goal can only be reached if he says to himself every day: "It can be done if I mean to do it and keep on meaning." But if he says that, and means it, the British car designer has nothing to fear from his confreres anywhere else in the world.

(Concluded.)

EXTRACTS FROM AN ENGINEER'S NOTEBOOK.

By "Practicus."

(Concluded from page 190.)

Rule for Alignment of Pulleys for "Skew" Drives.

A plumb-line dropped from the centre of the face of the upper pulley, on the side which the belt *leaves*, must be exactly central with the face of the lower pulley on which the belt *comes*. Always use crowned pulleys for "skew" or "quarter-twist" drives. This form of drive will not admit of fast and loose pulleys or a shifting belt.

Anti-freezing Compound for Gas or Oil Engines.

When the circulating tanks of internal-combustion engines are fixed in an exposed situation, and liability to frost effects is feared, the following compound added to the circulation water will be found an effective safeguard. Calcium-chloride 1 lb. to 1 gallon of water for temperatures down to 27 deg. Fah.; double this amount of calcium-chloride to 1 gallon of water for temperatures down to 18 deg. Fah.

Converting Inches of Mercury to Pound per square inch.

Vaccum is seldom registered in pound per square inch, but in inches of mercury. To convert a reading of inches of mercury into pounds per square inch, the former must be multiplied by 0·491.

To Ascertain Percentage of Vacuum.

If a vaccum gauge registers 28 in. of mercury while the barometer stands at 30 in. of mercury, then the vacuum percentage is:—

$$\frac{28}{30} \times 100 = 93{\cdot}4 \text{ per cent.}$$

To Ascertain the Power Required to Drive a Fan.

The rule is to multiply the number of cubic feet of air by the pressure in inches as denoted on the water gauge, and divide the product by 4,500.

Example.—Required, the power to drive a fan having a capacity of 50,000 cubic feet of air at 2·5 inches water-gauge pressure. Then:—

$$\frac{50{,}000 \times 2{\cdot}5}{4{,}500} = 27{\cdot}7 \text{ horse-power.}$$

Black Varnish for Cast Iron or Forgings.

A durable and rust-proof varnish can be made of ½ lb. lampblack, ½ lb. resin, 1 lb. ashphaltum, one quart turpentine, and a sufficient quantity of linseed oil to make the lampblack into a paste. The other ingredients to be then added and mixed thoroughly.

Determining H.P. of Alternating Current Motor.

For single-phase alternating current, the rule is to multiply together volts and amperes of the input, and divide by 746. Correct this for efficiency by multiplying by the efficiency per cent, and dividing by 100; and also for power factor by again multiplying by the factor known or stated.

$$\text{Thus H.P.} = \frac{\text{volts} \times \text{amps.} \times \text{efficiency per cent} \times \text{power factor}}{746 \times 100}$$

Flow of Water over V-Notch.

The mean of the gauge readings is taken, as recorded every few minutes, which gives the height of water flowing over the notch—which must be exactly 90 deg.—the gauge reading from the bottom of the V. Then $Q = c \times h^{\frac{5}{2}}$, where Q = quantity flowing over notch in cubic feet per minute, h = the depth of water in decimals of a foot above bottom of notch; c = a coefficient: ·305 for result in cubic feet; or 1·903 if in gallons per minute.

Cutting a Metric Thread with English Pitch Screw.

A gear wheel of either 63 or 127 teeth is required. Then the ratio between the metric measurement and the English lead screw is $\frac{63}{800}$ for a lead screw of ½-in. pitch, or $\frac{63}{400}$ for one of ¼-in. pitch. In calculation, 63 requires to be multiplied by the desired pitch in m/m.; thus, if a screw of 12 m/m. pitch is required, then using a lead screw of ½-in. pitch, $\frac{63 \times 12}{800} = \frac{756}{800}$ which represents the ratio of the change gears required. Hence, $\frac{756}{800} = \frac{63 \times 40}{40 \times 12} = \frac{63 \times 30}{100 \times 20}$; two of these factors having been multiplied by 2½ in order to get suitable gears in the train.

Fuel Economies.

The value of an economiser in connection with a steam boiler may briefly be exemplified in the following calculations. The saving in fuel due to increasing the feed-water temperature may be approximately shown as follows:—Heat saving (%) $= 100\,(T - t) \div [H - (t - 32)]$. Where T = the temperature of feed-water after heating; t = the temperature of the feed-water before heating, and H = the total heat above 32 deg. Fah. per pound of steam at boiler pressure.

In this connection it is commonly assumed that a fuel saving of 1 per cent for each 10 deg. Fah. increase in the feed-water temperature may be effected, together with a 20 deg. Fah. reduction in the flue-gas temperature. The resultant gain effected on horse-power terms on account of the use of an economiser may be expressed by the formula $H.P. = W(T - t)S \div 33{,}479$. Where W = the weight of flue gases passing per hour; T = the temperature of gases entering economiser; t = the temperature of gases leaving the economiser; and S = the specific heat of the flue gases.

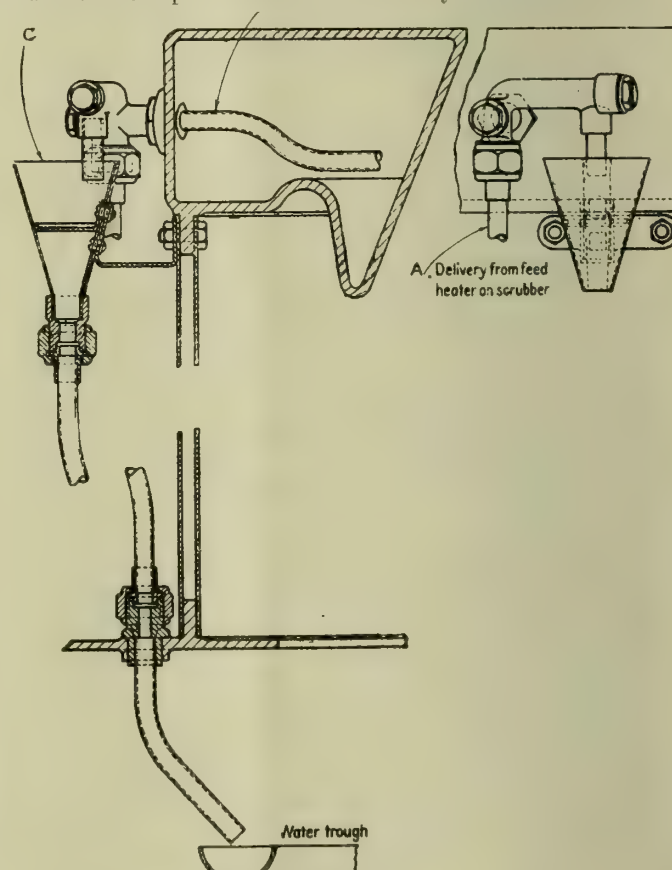
(*Concluded.*)

PRODUCER GAS FOR MOTOR VEHICLES.

By D. J. Smith.

(*Continued from page 192.*)

The fitting of the vaporiser or boiler brought into prominence the effect of the varying level due to the rolling of the vehicle on uneven roads. This was overcome after many failures by the simple device shown in Fig. 6. The water from the pump enters the vaporiser by the pipe A so long as the level is below the desired point, which is regulated by the height of the pipe B. When this level is reached, no more water enters, and thus the water in the vaporiser is not cooled out by an excess of water.



Producer Gas — Fig 6.

The surplus water passes into the cup C, and is led to a channel in the ashpan under the firebars. This channel is filled with asbestos cord and soaks up the surplus water which is vaporised by the heat of the firebars. The delivery pipe is taken into the centre of the vaporiser and acts also as an overflow pipe. When the vehicle rolls, this pipe, opening near the centre of the vaporiser, is scarcely affected by the variations in level, and little, if any, of the water already in the vaporiser overflows. The stroke of the water pump is adjusted as far as possible to give the correct quantity of water, so that there should, in normal running on good roads, be little or no overflow from the vaporiser. Any water in excess of what can be absorbed by the asbestos-filled channel in the ashpan is discharged by the ash valve in the bottom of the ashpan.

The producer so far was only controlled by the speed of the engine, and owing to the small quantity of fuel and water in the producer at any one time, it was necessary to control it by the

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 68 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 0 8	12 0 16	0 18 0 24	1 4 1 4	1 10 1 12	1 16 1 20	2 2 2 0	2 8 2 8	2 14 2 16	0
1	0 2 12	6 2 20	12 3 0	0 18 3 8	1 4 3 16	1 10 3 24	1 17 0 4	2 3 0 12	2 9 0 20	2 15 1 0	1
2	1 0 24	7 1 4	13 1 12	0 19 1 20	1 5 2 0	1 11 2 8	1 17 2 16	2 3 2 24	2 9 3 4	2 15 3 12	2
3	1 3 8	7 3 16	13 3 24	1 0 0 4	1 6 0 12	1 12 0 20	1 18 1 0	2 4 1 8	2 10 1 16	2 16 1 24	3
4	2 1 20	8 2 0	14 2 8	1 0 2 16	1 6 2 24	1 12 3 4	1 18 3 12	2 4 3 20	2 11 0 0	2 17 0 8	4
5	3 0 4	9 0 12	15 0 20	1 1 1 0	1 7 1 8	1 13 1 16	1 19 1 24	2 5 2 4	2 11 2 12	2 17 2 20	5
6	3 2 16	9 2 24	15 3 4	1 1 3 12	1 7 3 20	1 14 0 0	2 0 0 8	2 6 0 16	2 12 0 24	2 18 1 4	6
7	4 1 0	10 1 0	16 1 16	1 2 1 24	1 8 2 4	1 14 2 12	2 0 2 20	2 6 3 0	2 12 3 8	2 18 3 16	7
8	4 3 12	10 3 20	17 0 0	1 3 0 8	1 9 0 16	1 15 0 24	2 1 1 4	2 7 1 12	2 13 1 20	2 19 2 0	8
9	5 1 24	11 2 4	17 2 12	1 3 2 20	1 9 3 0	1 15 3 8	2 1 3 16	2 7 3 24	2 14 0 4	3 0 0 12	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	5·67	11·34	17·01	22·68	1 0·35	1 6·02	1 7·69	1 17·36	1 23·03	2 0·7	2 6·37	2 12	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 68 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Ft.
0	..	3 0 2 24	6 1 1 20	9 2 0 16	12 2 3 12	15 3 2 8	18 4 1 4	21 5 0 0	24 5 2 24	27 6 1 20	0
10	0 6 0 8	3 6 3 4	6 7 2 0	9 8 0 24	12 8 3 20	15 9 2 16	18 10 1 12	21 11 0 8	24 11 3 8	27 12 2 0	10
20	0 12 0 16	3 12 3 12	6 13 2 8	9 14 1 4	12 15 0 0	15 15 2 24	18 16 1 20	21 17 0 16	24 17 3 12	27 18 2 8	20
30	0 18 0 24	3 18 3 20	6 19 2 16	10 0 1 12	13 1 0 8	16 1 3 4	19 2 2 0	22 3 0 24	25 3 3 20	28 4 2 16	30
40	1 4 1 4	4 5 0 0	7 5 2 24	10 6 1 20	13 7 0 16	16 7 3 12	19 8 2 8	22 9 1 4	25 10 0 0	28 10 2 24	40
50	1 10 1 12	4 11 0 8	7 11 3 4	10 12 2 0	13 13 0 24	16 13 3 20	19 14 2 16	22 15 1 12	25 16 0 8	28 16 3 4	50
60	1 16 1 20	4 17 0 16	7 17 3 12	10 18 2 8	13 19 1 4	17 0 0 0	20 0 2 24	23 1 1 :0	26 2 0 16	29 2 3 12	60
70	2 2 2 0	5 3 0 24	8 3 3 20	11 4 2 16	14 5 1 12	17 6 0 8	20 6 3 4	23 7 2 0	26 8 0 24	29 8 3 20	70
80	2 8 2 8	5 9 1 4	8 10 0 0	11 10 2 24	14 11 1 20	17 12 0 16	20 12 3 12	23 13 2 8	26 14 1 4	29 15 0 0	80
90	2 14 2 16	5 15 1 12	8 16 0 8	11 16 3 4	14 17 2 0	17 18 0 24	20 18 3 20	23 19 2 16	27 0 1 12	30 1 0 8	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	30 7 0 16	60 14 1 4	91 1 1 20	121 8 2 8	151 15 2 24	182 2 3 12	212 10 0 0	242 17 0 16	273 4 1 4	303 11 1 20	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 69 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 0 18	12 1 8	0 18 1 26	1 4 2 16	1 10 3 6	1 16 3 24	2 3 0 14	2 9 1 4	2 15 1 22	0
1	0 2 13	6 3 3	12 3 21	0 19 0 11	1 5 1 1	1 11 1 19	1 17 1 9	2 3 2 27	2 9 3 17	2 16 0 7	1
2	1 0 26	7 1 16	13 2 6	0 19 2 24	1 5 3 14	1 12 0 4	1 17 3 22	2 4 1 12	2 10 2 2	2 16 2 20	2
3	1 3 11	8 0 1	14 0 19	1 0 1 9	1 6 1 27	1 12 2 17	1 18 2 7	2 4 3 25	2 11 0 15	2 17 1 5	3
4	2 1 24	8 2 14	14 3 4	1 0 3 22	1 7 0 12	1 13 1 2	1 19 1 20	2 5 2 10	2 11 3 0	2 17 3 18	4
5	3 0 9	9 0 27	15 1 17	1 1 2 7	1 7 2 25	1 13 3 15	2 0 0 5	2 6 0 23	2 12 1 13	2 18 2 3	5
6	3 2 22	9 3 12	16 0 2	1 2 0 20	1 8 1 10	1 14 2 0	2 0 2 18	2 6 3 8	2 12 3 26	2 19 0 16	6
7	4 1 7	10 1 25	16 2 15	1 2 3 5	1 8 3 23	1 15 0 13	2 1 1 3	2 7 1 21	2 13 2 11	2 19 3 1	7
8	4 3 20	10 0 10	17 1 0	1 3 1 18	1 9 2 8	1 15 2 26	2 1 3 16	2 8 0 6	2 14 0 24	3 0 1 14	8
9	5 2 5	11 2 23	17 3 13	1 4 0 3	1 10 0 21	1 16 1 11	2 2 2 1	2 8 2 19	2 14 3 9	3 0 3 27	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 5·75	0 11·5	0 17·25	0 23·0	1 0·75	1 6·5	1 12·25	1 18	1 23·75	2 1·5	2 7·25	2 13	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 69 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	.	3 1 2 12	6 3 0 24	9 4 3 8	12 6 1 20	15 8 0 4	18 9 2 16	21 11 1 0	24 12 3 12	27 14 1 24	0
10	0 6 0 18	3 7 3 2	6 9 1 14	9 10 3 26	12 12 2 10	15 14 0 22	18 15 3 6	21 17 1 18	24 19 0 2	28 0 2 14	10
20	0 12 1 8	3 13 3 20	6 15 2 4	9 17 0 16	12 18 3 0	16 0 1 12	19 1 3 24	22 3 2 8	25 5 0 20	28 6 3 4	20
30	0 18 1 26	4 0 0 10	7 1 2 22	10 3 1 6	13 4 3 18	16 6 2 2	19 8 0 14	22 9 2 26	25 11 1 10	28 12 3 22	30
40	1 4 2 16	4 6 1 0	7 7 3 12	10 9 1 24	13 11 0 8	16 12 2 20	19 14 1 4	22 15 3 16	25 17 2 0	28 19 0 12	40
50	1 10 3 6	4 12 1 18	7 14 0 2	10 15 2 14	13 17 0 26	16 18 3 10	20 0 1 22	23 2 0 6	26 3 2 18	29 5 1 2	50
60	1 16 3 24	4 18 2 8	8 0 0 20	11 1 3 4	14 3 1 16	17 5 0 0	20 6 2 12	23 8 0 24	26 9 3 8	29 11 1 20	60
70	2 3 0 14	5 4 2 26	8 6 1 10	11 7 3 22	14 9 2 16	17 11 0 18	20 12 3 2	23 14 1 14	26 15 3 26	29 17 2 10	70
80	2 9 1 4	5 10 3 16	8 12 2 0	11 14 0 12	14 15 2 24	17 17 1 8	20 18 3 20	24 0 2 4	27 2 0 16	30 3 3 0	80
90	2 15 1 22	5 17 0 6	8 18 2 18	12 0 1 2	15 1 3 14	18 3 1 26	21 5 0 10	24 6 2 22	27 8 1 6	30 9 3 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	30 16 0 8	61 12 0 16	92 8 0 24	122 3 4 14	154 0 1 12	184 16 1 20	215 12 2 0	246 8 2 8	277 4 2 16	308 0 2 24	

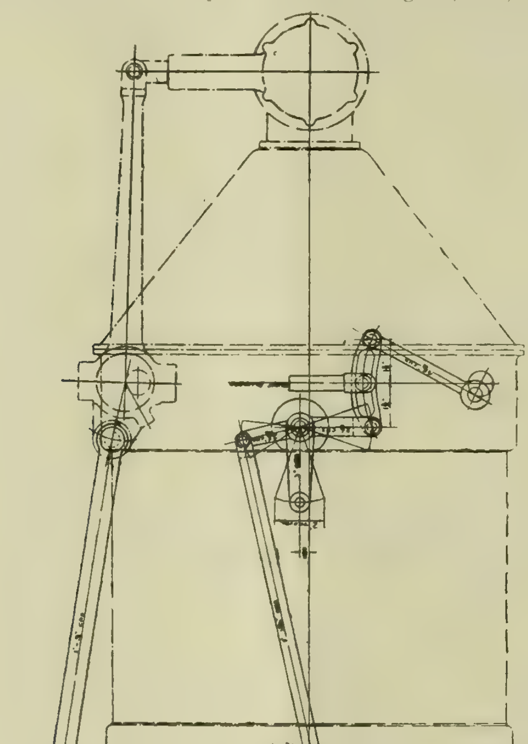
Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

speed or the load if conditions of working were to remain constant, as otherwise more fuel and water would be fed with the engine running fast with little or no load than would be fed with the engine running slowly at full load. Two devices were tried to overcome this. The first was a variable-speed device between the engine and the producer. While this would be suitable for large plants, it was not found entirely suitable for vehicle work, and the device shown in Fig. 7 was adopted. In this the stroke of the fuel feed device and the stroke of the water pump are varied.

The short free lever in the centre is coupled to the engine throttle, and as the throttle is opened the stroke of the lever is increased. The minimum permanent adjustment is obtained by altering the position of the crank pin driving the water pump and the lever working the fuel feeder, the running adjustment being given by the variable device.

It is of interest to note that the illustrations of a producer and scrubber on the author's system, shown in Figs. 3, 4, 5, and 7, are one-eighth full size of a 50 H.P. plant. These, with the description given, should make the construction quite clear.



PRODUCER GAS.—FIG. 7.

Absolute accuracy is out of the question when dealing with fuel such as coal, which varies in size and quality, but it is possible to limit the variation of the thickness of the fuel bed to a surprising degree, a difference of less than 1 in. being found after a run of 50 miles, and this is quite accurate enough for all practical purposes.

The Scrubbing or Filtering of the Gas.

Until the invention of a producer which gives a gas free of all volatile constituents in the fuel, the scrubbing of the gas was the greatest difficulty in the way of adopting producer gas to motor vehicle work.

With a gas free from all tarry or condensible constituents, it is merely necessary to remove the dust held in suspension, and this is a very much easier task than scrubbing in a wet scrubber. The author tried many devices, notably coke-filled cylinders, trays of sawdust and pads of wood wool, asbestos wool, etc., but abandoned these in favour of the device shown in Fig. 6, which incorporates a feed heater and gas filter in one unit, thus economising room and weight. Coke and other materials form very efficient filters if the driver gives them regular attention and replaces them periodically with fresh material. To rely on the average driver doing this is, in many cases at least, to invite trouble with the plant, and the author thought it better not to rely upon any arrangement which called for renewal or cleaning at long intervals, but to insist on a daily clean out of the filter. It was essential that this should not demand any skill or require much time or trouble in opening up the scrubber and filter, and the arrangement shown in Fig. 6 fulfils these conditions. The device is in three sections—

(1) The feed heater.
(2) The cooling tubes.
(3) The filter tubes.

The gas from the producer enters the top header at the left-hand end, and passes down the internal tube of the feed heater, which at the lower end is coned, and this tends to increase the velocity of the gas. The gas then expands into a settling chamber or pot, and in doing so drops a very large percentage of dust in suspension. It then leaves the settling chamber by an annular passage and passes up and down two or more banks of cooling tubes. In these tubes and the headers more dust is deposited. Finally, the gas passes up two or more large diameter tubes, which are fitted with fine gauze filters of conical shape, the filter fitting the bore of the tube at the lower end and terminating at a point at the upper end; to this a cross handle is attached, which allows the filter to be easily withdrawn through the door in the top header. An arrangement is also provided whereby any filter can be closed off and withdrawn for cleaning without stopping the action of the producer, but this is not likely to be required for vehicle work. The gas on leaving the filters is clean enough for all practical purposes, and carries no more dust than is drawn into the air inlet of a carburettor when the roads are dusty. The cleaning of the filter is simple, and only takes two or three minutes. The doors are opened, the gauze filters withdrawn, and water is poured in at the top doors and all dust washed out; the gauze filters are then shaken and replaced. The water from the feed pump on the producer enters the feed heater at the bottom opening and leaves at the top to the vaporiser. This cools the gas considerably and also recovers much valuable heat which would otherwise be lost. The combined feed heater and filter is very small and can be easily accommodated on the dashboard on the side opposite to the producer. Many other forms of filters will, no doubt, be possible, but the author thinks it will be difficult to evolve a design which at once meets the requirements and is of less weight and size.

The material found in the filter is merely the fuel dust, which is quite dry and clean, and no trace of any tarry substance likely to cause trouble with the engine has ever been found.

For use with petrol engine having enclosed valves, some further filtering may be necessary owing to the very small clearance in the valve stems. (See notes on the use of producer gas in petrol engines.) For this purpose the gas after leaving the scrubber can be taken through a small water seal, the gas pipe from the scrubber dipping about 1 in. or $1\frac{1}{2}$ in. under the surface of the water, and the level of the water being maintained by a float chamber. The consumption of water would be very small, and, except for very long runs, no extra supply would be required and the float feed could be dispensed with.

For use on agricultural machinery, tractors, etc., where the engine runs for long periods at high speed while the vehicle is either stationary or moving slowly, the scrubber should be so placed that it gets the benefit of the radiator fan blast, and a water filter, as fitted to the air inlet of some agricultural tractors, should be fitted on the induction pipe.

The water seal or filter chambers should be washed out at the end of each day's work.

Mixing Valves.

It was no easy matter to discover the best type of mixing valve or gas carburettor for producer gas used in an engine running at widely differing speeds and loads; on stationary work, the loads are in comparison rock steady, and the mixture, once set, needs no alteration in the case of engines governed on the throttle. In other types, the mixture is varied according to the load, the gas valve being given more or less lift and the air inlet remaining constant. Neither of these methods can be adopted on motor vehicles using the normal design of engine. The author

tried many types of gas mixing valves and gas carburettors with little success. Most of these were designed to work with gas delivered under a slight pressure, and were useless where the gas had to be drawn into the mixing chamber and where the amount of gas used in proportion to the air is large. Producer gas is also much richer at starting than when running, and needs a much larger air volume. The suction on the producer should also be maintained as steady as possible at all loads and speeds. The author finally adopted an arrangement in which no mixing valve as such was employed. The induction pipe or the gas pipe from the scrubber to the engine was enlarged in diameter for a short distance before reaching the inlet manifold. Close to the inlet manifold a throttle valve of the usual type, but rather more substantially built, was fitted. About 4 in. above the throttle valve a number of slots were cut in the gas pipe, and over these a rotating sleeve also pierced with slots was fitted. By partially rotating the clip the holes in the gas pipe could be varied in area to any extent. About 4 in. above these holes an ordinary automatically-operated air valve having an area equal to half that of the gas pipe was fitted, the tension on the valve spring being adjustable. The air slots are opened wide for starting up and partially closed down as the engine gets away, when the chief part of the necessary air supply is then furnished by the automatic valve. When the throttle is nearly closed, sufficient air enters through the air slots. This device, while not perfect, answers remarkably well in practice, is extremely simple and cannot get out of order. The starting adjustment of the air sleeve is no more difficult than the same operation on a petrol vehicle, and there are no moving parts, apart from the throttle, in contact with the mixture. Variations in the fuel can be met by adjusting the tension of the spring on the automatic valve, an operation which takes a few seconds only. The design of producer gas mixing valves or carburettors will no doubt receive a considerable measure of attention, and the author would suggest this as an interesting field of research.

Refractory Lining of the Producer.

The refractory lining of the producer for motor vehicle work is a very important subject and one to which the author devoted much time, the experence gained with stationary plants not being of much use in this connection. In stationary practice, it is no uncommon thing to use linings 6 in. thick, a layer of sand 2 in. or more in thickness being interposed between the lining and the metal case of the producer.

To fit linings of this thickness was obviously an impossibility for vehicle work; the weight and size of the producer would have been prohibitive, and the cost of renewal not an inconsiderable item. A very thick refractory lining is equivalent to a thick metal bush or bearing on a shaft; long before it is worn through, it is worn too much to be workable. The author, therefore, adopted a comparatively thin lining—1½ in. thick—and found this quite satisfactory, and owing doubtless to the comparatively rapid passage of heat through this small thickness, its life was far longer in proportion than the usual thick lining. In order not to lose the heat conducted through the lining, the author jacketed the outside of the producer casing with another case, leaving an annular space between. This will be clearly seen from Figs. 3 and 4. All the air entering the producer passes through this annular space, and the heat conveyed through the lining, which would otherwise be lost, is utilised, and appreciably helps the flexibility of the producer. In stationary practice, cold air is drawn directly into the vaporiser or fire without any preheating, and to some extent negatives the effect of the thick refractory lining.

Actually, the use of the refractory lining is to prevent the rapid burning out of the metal casing of the producer. The author tried, for vehicle work, jacketing the producer with water, using a thin refractory lining, as already indicated, and thus obtaining a large supply of steam, if necessary, under slight pressure. For this purpose such a form of construction was found to be useless, as there was no method of controlling the amount of heat passing to the water, and, therefore, the steam supply was erratic, as it naturally depended on the pressure in the vaporiser jacket, and not on the requirements of the engine.

Even the weight of the thin lining used was considerable, and the author tried other material than the standard firebrick composition to see if this weight could not be lessened to some extent while retaining a melting point high enough to withstand the work. The melting point of the best firebricks are as follows :—

Alumina	2,100 deg. Cen.
Magnesia	2,720 deg. Cen.
Magnesite	2,165 deg. Cen.

The melting temperature of these is much above any temperature which should be reached in a producer if working correctly, and in this respect these materials are satisfactory, but the specific gravity ranges from 2 to 2·2 and the weight per cubic foot from 120 lb. to 137 lb.

This led the author to try a lining having a diatomic base. The melting point is comparatively low, but the weight per cubic foot is only 43·5 lb. and the specific gravity 0·7. It by no means follows that the lining with the highest melting point stands up longest in work, but it is quite likely that in ordinary producer practice, where clinkers are allowed to form and heavy bars have to be used to detach fused masses from the refractory linings, a diatomic lining would not last. In the author's system of working where no clinkers form, and no poking is required, the lining stands well and effects a most remarkable saving in weight. The method of regulating the steam supply, which maintains the fire temperature relatively constant, prevents any danger of melting the lining, the correct working temperature being well below the melting point of the lining.

The lining can either be fitted in the form of curved slabs set in fireclay, or it can be fitted in one piece in the form of a cylinder moulded and baked to the correct dimensions. This is the most satisfactory manner, the linings being purchasable for a few shillings each, and capable of being fitted in a few minutes without any need of bedding in with fireclay or similar cement. The life of the lining in normal work should average about 12 months.

(To be continued.)

THE SELECTION AND MAINTENANCE OF BELTS.*

By HARTLAND SEYMOUR.

THE problem of the economical transmission of power in workshops is one that confronts every works manager to-day, but not all of them possess a knowledge of the factors necessary in the economical selection of belting.

The belt section of the transmission system is initially exceedingly expensive, and usually looms very large on the maintenance account, due as much to the choice of an unsuitable belt as to its inefficient running.

The chief factors to be borne in mind when selecting a belt are:—

1. The horse-power the belt will be required to transmit.
2. The speed of the machine to be driven.
3. The distance between the pulley centres.
4. The conditions under which the belt is expected to work.

To find a suitable belt to satisfy the first condition, it is always advisable to consult the conservative tables of power transmission, as those issued by manufacturers usually vary, sometimes considerably. In this connection it is as well to remember that up to a certain limit the higher the velocity of the belt the more horse-power will it transmit.

If a belt is run at a speed of more than 4,000 or 5,000 ft. per minute, centrifugal force will come in and tend to lift the belt from the pulley face, resulting in loss of power through slip.

The author has found that the highest speed a belt may be run at from an economical point of view is about 4,500 ft. per minute. If a belt is run at, say, 5,000 ft. per minute, centrifugal force plays a very important part, and is, without doubt, a determining factor in the life of the belting.

The path of a belt with a velocity of 4,500 to 5,000 ft. per minute, if watched, will be seen to

* *Cheap Steam.*

be very irregular. It runs laterally, from side to side of the pulleys, while the slack "run" will be wavy. These phenomena are especially noticeable in a thin belt. This wave action causes the belt to jump when it reaches the pulley, so that where it would normally be in contact with the pulley face, the jump decreases the surface of contact. This is detected by the "slapping" of the belt. In the case of a laminated belt, that is, one of several thicknesses sewn together, the slapping due to running at a very high speed sets up disintegration, with the subsequent ruining of the fabric.

When a high speed and fair width is required of a belt then the thickness should be increased. A thicker belt is naturally not so pliable as a thin one, and is less liable to jump about when moving at a high speed.

The distance between the pulley centres is also important, as it is here that the factor of belt pliability comes in. It is obvious that for short drives a wide, thin belt is more pliable than a thick narrow one, and is more economical even though it will necessitate the use of wider pulleys. If the pulley centres are close together, less than 5 ft. apart, say, then the pliability of the belt is exceedingly important. In cases like these, and subject to the other conditions, the author has found a woven cotton belt to be extremely serviceable, as it is more pliable than stitched canvas, leather or rubber. If a woven cotton belt is used and treated with a compound, extreme care must be exercised in the choice of that compound. Should it be of a tarry or bituminous nature the state of that belt after treatment is likely to be considerably worse than before. A thicker belt will not bend round the pulley so easily, consequently lessening the arc of contact and resulting in slip.

It has been stated by one authority on belting that the most efficient drive is obtained when the pulley centres are about 20 ft. apart, and this is a very useful guide in practice, where leather is concerned. When the pulley centres are closer together than, say, 16 ft., the necessity for "taking up" the belt becomes more frequent. If the distance between centres is more than 25 or 30 ft. the "wave action" referred to above is very noticeable, and this drive will be less efficient than that with centres less than 16 ft. apart.

The conditions under which the belt is expected to work are worthy of very careful consideration, as it is natural that not any one type of belting is suitable under all or any conditions of service. If the conditions are such that oil or grease cannot be kept from the belt, then rubber should not be used, as it deteriorates very rapidly when brought into contact with either of these lubricants. Properly treated cotton belting has been used with success under these circumstances.

In practice it is usually found that every works engineer confines himself to one type of belt, though the working conditions may vary from shop to shop in the same factory. This is, no doubt, a habit, and one which it is not easy to be rid of. As long as the belt runs apparently satisfactorily nobody worries about it, and when a new one is required a belt of the same type is obtained without considering the merits of other types. This is a great mistake, though it should not be inferred that belts in good running order should be changed. It will, however, pay works engineers to study their shop conditions very carefully, to experiment sometimes, and even to obtain expert assistance.

Another factor in the successful maintenance of a belt is the necessity for occasional tightening on account of stretch. Observant works managers have probably noticed that, instead of the necessity for "taking up" a belt arising at regular intervals, it is spasmodic. This is usually attributed to three reasons.

Firstly, when a belt is new the amount of stretch is considerable, some belts having to be tightened twice during the first 200 hours of running. The stretch after about a month apparently diminishes. This is due to the fact that the newness has worn off and the initial stretching is over.

Secondly, when a belt has run for three months or so, the periods between taking up are more or less regular. The belt is now at its maximum possible efficiency and the amount of stretch is uniform.

Thirdly, when the belt is becoming worn out frequent repairs are necessary. The belt is suffering from internal disintegration, which, once initiated, rapidly spreads and eventually results in the scrapping of the belt.

On a moderately long drive, say 20 ft. from shaft pulley to machine pulley, it is found in practice preferable to use a thick narrow belt instead of a thin wide one. The thick belt is stronger and does not tend to "wave" as the thin belt will do. Besides this, a thick belt can be shifted more easily on to an idle pulley. The thin belt will tend to corrugate, curl up at the edges and will sometimes get tangled up in any adjacent gear, resulting in accidents and breakdowns.

When fitting a new belt in the transmission system the question of joining the ends naturally crops up. This question deserves far more consideration than is usually given to it. It is well known that, whenever possible, a belt should be spliced and then cemented. Belts treated in this manner have much longer lives than when the ends are wired or laced together.

Splicing a belt is thought to entail more trouble than simply hooking or lacing it, but the user will be amply repaid in the long run. The laced joint is the weakest part in the belt, whereas a well-spliced and cemented joint should be quite as strong as the fabric.

Although it is not always practicable, it is far better to adjust the driving centres when a belt is running slack than to tighten up. The advantage is that the joint is not in any way interfered with. If no provision for the adjustment of centres has been made, it is good practice to measure the tension in the belt each time it is tightened up, so that the same tension may be maintained and the strain in the belt uniform. One authority states that in his experience it is safe to shorten a double belt by half an inch for every 10 ft. of its length when the total load is about 110 lb. per inch of width of the belt.

If belts are kept running continuously, day and night, as they are in some factories, an idle pulley should be installed so that the belt may be run on to

it when it becomes slack. This pulley should be on the slack run of the belt.

At regular intervals of, say, six months all belts should be scraped and a grease rubbed into the fabric. The exact type of the grease to be used will generally be specified by the belt manufacturer. The regular greasing of a belt will keep it supple and moist, and prevent hardening with subsequent cracking of the fabric. It is extremely important that the surface of a belt should not be allowed to become clogged with dirt, and that as far as possible oils should not come in contact with it as these lead to rapid deterioration.

The above especially applies to cotton fabric belts, as these have to be very carefully impregnated to protect them from water, oil and chemical fumes. The substance for impregnation should be of a non-acid, non-alkali composition so as to impart that "velvety" cling to the surface which ensures a good grip on the pulley face.

The old idea of running a belt as tightly as possible has now been shown to be impractical. It is now the object to run belts as slackly as possible, so that instead of an arc of contact of 180 deg. or less, it is possible to obtain an arc of 200 deg. and sometimes more with a really good compound.

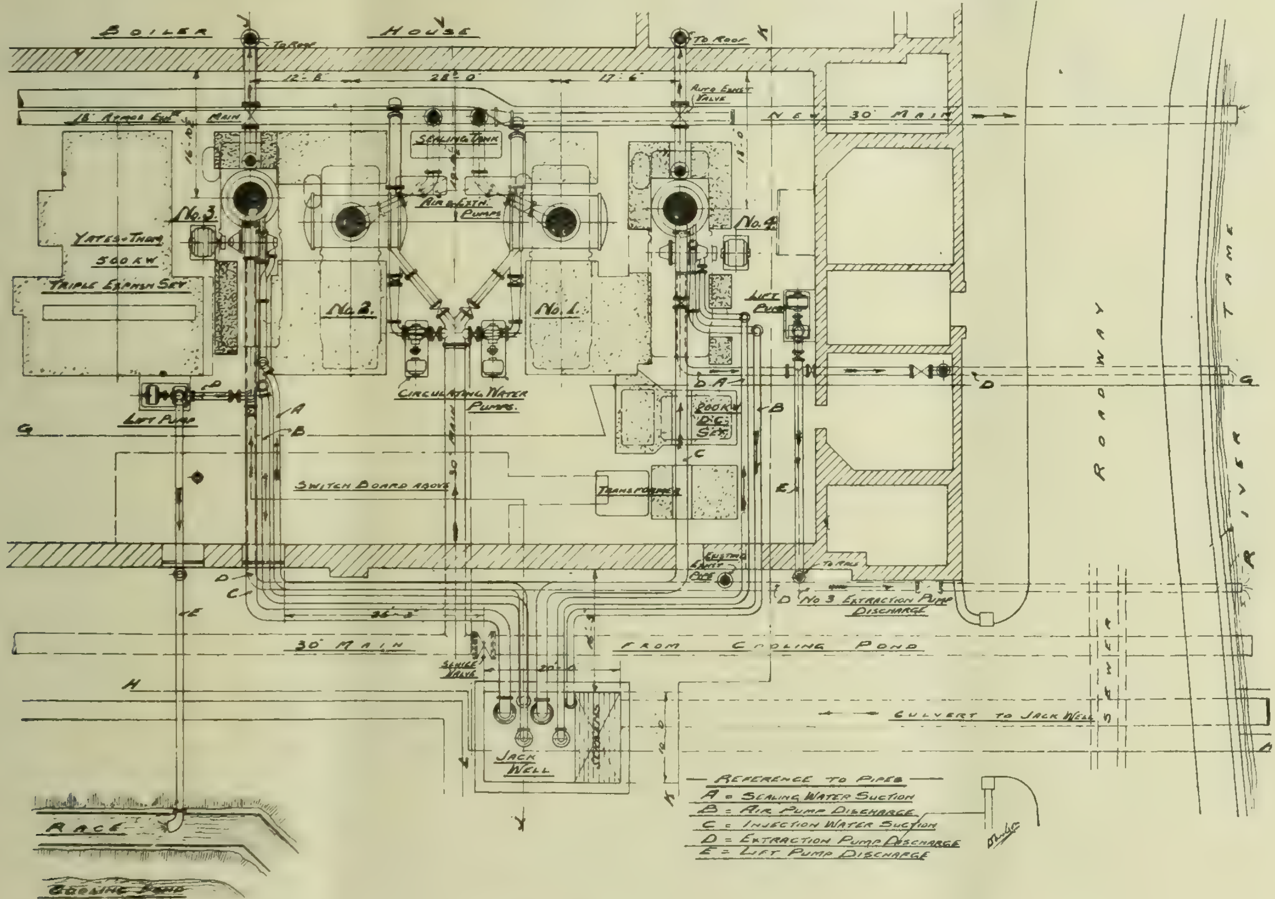
It is most important that there should be a "maintenance" gang in every factory employing a large number of belts. The duties of this gang would be to inspect every belt in the plant regularly, and it is necessary that they should know how to tighten up a belt without damaging it. Every belt should be inspected at least once a week, so that defects could be detected by an experienced hand with the object of forestalling, if possible, a breakdown caused by an inefficient belt.

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By DOUGLAS WILSON, A.M.I.Mech.E.

(Continued from page 144.)

THE two first turbo sets which were placed on the existing concrete foundations to the Nos. 1 and 2 Yates and Thom sets are shown on the layout drawings, at Figs. 88, 89 and 90, their views being respectively the plan, and sections through G.G. and L.L. being complete with surface condensers, air pumps, etc. These units are numbered 1 and 2, No. being on the river side of station, and so on, though actually now the units are numbered from the other end, these numbers being painted in large figures on the bedplates, but this is a minor point; we shall number them in the order in which they were installed.



ENGINEERING LAY-OUT.—FIG. 88.

As will be seen from the arrangement, a considerable amount of cutting was necessary to accommodate the condensers in the existing concrete foundations, the opening for same being some 10 feet wide, also the electric end of the foundations had to be cut away to provide room for the circulating pumps,

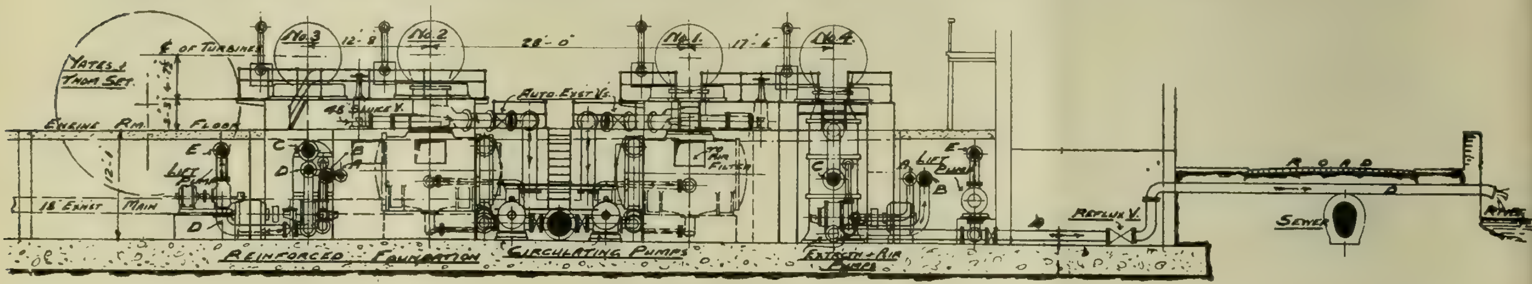
leaving a clear width between the foundation walls of 18 ft. 6 in.

The adjacent working Yates and Thom and other sets in the station required covering round with canvas screens, etc., to ward off the dust as much as possible during these operations, and it was fortunate that no damage was done to them. Owing to the necessary height required to the exhaust steam inlet flange on the 48 in. main exhaust valve, the gantry floor level, *i.e.*, the under side of turbine bedplate was fixed 3 ft. 3 in. above the present engine room floor, so this meant adding to the height of the existing foundations this amount, the new level being kept the same on all the further sets, making a very imposing installation.

The turbine bedplate is carried over the 10 ft. opening for condenser on four 14 in. × 6 in. rolled steel joists, two on each side, the ends of same being firmly built in the concrete foundation. The alternator end of bedplate is fronted direct on to the concrete foundation, a portion of it resting on the 14 in. × 6 in. joists above referred to. An air chase was formed at this end of the foundation, communicating with the existing air filter in the basement; this chase was about 4 ft. wide, so did not weaken the foundations, as 10 in. × 6 in. joists were built across this duct, the end one carrying the cast-iron brackets for supporting the gantry chequer plating.

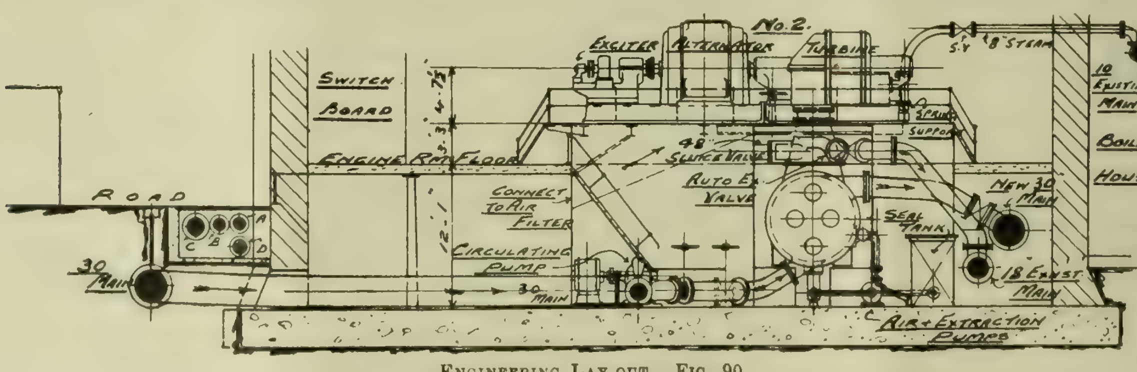
The method of grouting in a turbine bedplate, levelling up on joists, etc., was dealt with in these articles at the beginning, so perhaps I will refrain from repeating the general way adopted. Turning now to the turbo-alternators, these were, as previously stated, made by the British Westinghouse Co., and the turbines are of the Rateau high-pressure impulse type. The steam consumption of each turbine is about 14 lb. per k.w. hour, the steam conditions being 175 lb. gauge, 540 deg. Fah. and 28¼ in. vacuum. As will be seen, the steam supply is taken off the 10 in. existing main in the boiler house, coupling up to turbine steam chest by large flexible bend shown, a stop valve being interposed, this enabling the turbine to be overhauled, etc., without uncoupling and blanking off, etc.

The spring support will be noticed at Fig. 90, this relieving any undue stresses on the steam chest, and the cast-steel tee-piece connected to same is provided at the bottom with a cock and drain pipe, communicating with steam trap in basement. The steam chest itself is also provided with cock and connection pipe to trap. The turbine is fitted with a set of five gauges, neatly mounted on a plate near the steam chest, the gauges showing pressures before stop valve and after governor valves, and at velocity stage, also the vacuum at turbine exhaust, and oil pressure.



ENGINEERING LAY-OUT.—FIG. 89.

Between the main exhaust outlet in the turbine and the steam inlet flange on the condenser is provided a 48 in. sluice valve, operated from the engine-room floor or gantry floor level, through a vertical hand wheel and mitre wheels as shown at Fig. 89. On the top side of this valve an outlet branch is formed, this communicating through an atmospheric valve direct to the existing 18 in. exhaust main in the basement; this main passing up the end wall of station to roof. This provides for the turbine exhausting direct to atmosphere automatically should the vacuum fail at any time due to air-pump breakdown, etc., as serious results might befall the plant owing to the building up of pressure in the condenser.



ENGINEERING LAY-OUT.—FIG. 90.

A copper expansion piece is fixed between the turbine exhaust mouth and the exhaust sluice valve, as will be seen, this allowing for any movement due to expansion. The automatic exhaust valve referred to instantly opens to atmosphere as soon as the vacuum fails, or atmospheric pressure is reached, viz., 14·7 per square inch.

These valves, as mentioned earlier on, should always be kept as close to the condenser as possible, and must be readily got at. By closing the main 18 in. exhaust sluice valve, of course, the turbine is completely cut off from the condensing plant,

enabling same to be repaired, etc. These large sluice valves take some time to open and close by hand (twenty minutes often), and are sometimes fitted with motors for operating them through suitable worm gear. As they are not frequently closed, however, the extra expense of the motor is not considered essential for plants up to this output.

Coming now to the condensing plant, this comprises—to each turbine—one surface condenser of 4,000 square feet cooling surface, the cooling water being supplied directly from the cooling pond, the height of water in same giving the necessary head required; or alternatively by the motor-driven circulating water-pump of a capacity of 4,100 galls. per minute, shown in Figs. 88, 89, and 90. This pump on each unit is only used as a standby or reserve, as in the very dry weather the river gets very shallow and the head of water at cooling pond becomes very low; in other words, the pumps save the plants from being shut down, should the avoidable head at pond get down due to any cause. An air pump of the Westinghouse-Leblanc rotary type is used in conjunction with each condenser, directly coupled to a 4 in. centrifugal extraction pump, both pumps being driven by a 23·5 B.H.P. motor, as will be seen on the plan.

The rotary type of air pump is now largely used on turbine installations; the space occupied by same is very much less than that required by the "Edwards" plunger type, hence one reason for their popularity.

CONNECTING-ROD BOLTS.*

RENEWAL, ANNEALING, OR HEAT TREATMENT.

Mr. W. C. Shettle, referring more particularly to his experience with Diesel engines in Barbados, mentioned that he had run engines for the last few years without any renewal of connecting-rod bolts. He considered, however, that, more particularly in the case of Diesel engine installations abroad, where the class of labour might not always be very reliable, and where there might, therefore, be a greater danger of improper tightening up of bolts, it was advisable to make a practice of renewing bolts at certain stated intervals.

Mr. Napier Prentice, President, stated that when the question of connecting-rod bolts was discussed on a previous occasion he had suggested that the practice of hitting up a bolt with an unknown length of spanner, weight of hammer, and especially with the unknown strength and spirit of the workman, should be replaced by a more scientific method, such as one based on the measurement of the elongation of the bolt due to the tightening up of the nut. He had had a bolt on a Willans Diesel engine measured before and after unscrewing, and the contraction was found to be 10/1000ths of an inch.

The particulars of the connecting-rod bolt in question were as follows:—

Elongation of Connecting Rod Big End Bolt—Willans Diesel Engine.

Diameter of bolt	45 mm.
Depth of head	29 mm.
Threads per inch	11
Depth of nut	95 mm.
Effective length under head to top of nut	410 mm.
Over-all length of bolt	450 mm.
Elongation as found under average strain (in practice at Felixstowe Electric Generating Works)	·010 in. 10/1000 in.)

Taking the length of the bolt under stress as the length between head and nut plus half the depth of the nut, the elongation, when tightened, worked out at about ·0007 in. for each 1 in. length of bolt under stress.

By adopting an elongation suitable for the material designed Mr. Prentice considered that the risk of breakage could be greatly reduced, and that in the event of a bolt cracking, the extension of length would indicate such a fault.

Mr. James Richardson said that, speaking from the point of view of manufacturers both of oil engines and of the materials from which they are made, including steels for connecting-rod bottom end bolts, he would like to give expression to the thanks that were due to the Diesel Engine Users' Association for the thorough way in which they had gone into the question of connecting-rod bottom end bolts. The subject was one of considerable importance in view of the facts that a number of failures had been recorded due to the fracture of bottom end bolts, and that where such failures did occur their consequences were generally of a relatively serious nature, calling for full investigation towards completely satisfactory preventative measures.

In dealing with the Hon. Secretary's communication giving an abstract of replies received from those firms to whom the list of questions regarding big end bolts had been submitted, strong disappointment would be felt, not only at the small percentage of replies which had been received, but also on account of the very conflicting nature of the information given and opinions expressed, which made it quite impossible to deduce any satisfactory solutions therefrom.

The subject resolved itself into three headings, viz., material working stresses and design. In regard to the material, undoubtedly what was required was a material possessing a high degree of toughness. Toughness, so far as he knew, had never been defined, but he would give a definition which might meet all similar cases. Toughness could be described as that quality in a material which ensures that when once cracked the crack will not expand, nor will further cracks occur until the material is again stressed to the same amount as caused the crack.

Applying this definition to connecting-rod bottom end bolts it would be seen that such a quality gave ample opportunity for periodic inspection to reveal cracks or defects since, should the bolt crack due to overstress, the stress would be automatically relieved until such time as the bolts were again tightened up.

There was no difficulty in obtaining materials to fulfil this condition; more could be said later on this point.

The two types of material which could be used were wrought iron and steel. Steel could, further, be divided up into ordinary steels and high tensile steels. Since several of the replies indicated a preference for wrought iron—and some engineers even to-day were pledged to wrought iron for parts subject to indeterminate and alternating stress—it might be mentioned that the one advantage possessed by wrought iron was that the slag inclusions which were present in all wrought iron prevented the structure—should it be crystalline—from being dangerously short in this respect, since the slag inclusions kept the crystals of relatively small size. Mr. Richardson wished to state emphatically that no part could become crystallised due to actual use in an engine. Crystallisation was either a defect in the manufacture of the material, or was caused by a part which had been highly stressed in use being wrongly heat treated. In regard to incorrect heat treatment, he might instance the reply which had been given to Question 2, as follows:—

"Raising the steel or iron to a temperature of about 900 deg. Cen. in a box packed with spent material and then allowing to cool in the box."

Such heat treatment could be absolutely guaranteed to have a detrimental effect on the quality of the material; and if the material had previously been subject to permanent strain such treatment would cause crystallisation. It was recommended in one reply that the material should be quenched in water only and then cooled in air. In his opinion quenching in oil was very much preferable to quenching in water, since such violent treatment as quenching in water was liable to produce cracks.

In view of the fact that the heat treatment of iron and steel was so little understood, and of the questionable expediency of carrying it out—in any case after the bolt has been in use—it would be preferable, he thought, to make a definite ruling that such heat treatment should not be carried out.

The case of chain slings and crane hooks was different, since in all probability they were definitely and repeatedly strained beyond their elastic limit. Annealing would remove this permanent strain and restore the ability of the material to withstand such loads for a certain number of times.

As to the question of the stressing of connecting rod bottom end bolts, this subject was naturally somewhat indefinite. The bottom end bolts of 4-stroke cycle engines were subject to tensile stress every second revolution, due to the inertia forces operating during the exhaust and suction strokes. These stresses were

* Discussion of the Diesel Users' Association at meetings held on Thursday, 23rd October, 1919, and on Thursday, 20th November, 1919.

very much augmented should the piston be tight, or should piston seizure partially or completely take place. Similarly with 2-stroke cycle engines: piston seizure might cause tension load on the bolt so that a fair factor of safety should be legislated for in the design of both 2- and 4-stroke cycle engines. Where there had been a case of piston seizure of any sort, connecting-rod bolts should be renewed without question. It would be seen, however, that with 4-stroke cycle engines the stress alternates between zero and a maximum depending upon the condition of the engine.

The diagram illustrated a method of arriving at the safe stress. Taking OC as representing the stress due to the steady load which could be withstood by the material (in other words, the elastic limit), and plus OA, minus OB, assumed equal, representing the alternating stresses which the material would indefinitely stand, then the lines joining C to A and B would give the range which could be withstood for any type of loading. For instance, the material would stand a stress alternating from O to P when the lower stress was zero.

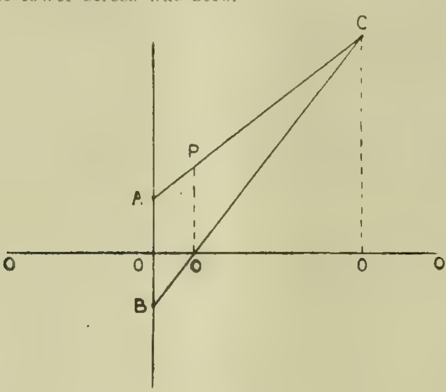


Fig. 1.

In the case of a bottom end connecting-rod bolt there were repeated stresses from zero to the tension load consequent upon inertia as well as the steady stress which was indefinite and caused by the tightening up of the bolt, intensified possibly by the different coefficients of expansion of the bottom end materials under working temperature. To take a numerical example to make the case quite clear: supposing the steady stress due to the tightening up of the bolt to be plus 5 tons per square inch, and the alternating stress due to the working tension to be from zero to plus 4 tons, then the range of stress would be from plus 9 to 5 tons per square inch, and from a diagram constructed in the manner indicated the elastic limit for the material, without a factor of safety, could be ascertained. This elastic limit should then be multiplied by a factor of safety of not less than 2. Mr. Richardson suggested a factor of 3, and said that one of 4 should be more than ample to provide for any contingencies.

The design of the connecting-rod bottom end bolt could be such that the body of the bolt is relieved for the major portion of its length to a diameter less than the diameter at the bottom of the thread. The material recommended was 3 per cent nickel steel, although no difficulty was experienced in getting a very tough material with an elastic limit up to 40 tons per square inch. Such materials, with a reasonable size of bolt, gave absolute security against failure, provided the material was suitably treated after forging in the makers' works.

The composition recommended was as follows: Nickel, 3 per cent; carbon, 0·40 per cent.; manganese, 0.5 to 0.6 per cent; silicon, 0·1 to 0·2 per cent; sulphur and phosphorus together to be less than 0·06. The steel before delivery should be heat treated at the makers, as only with heat treating could the full benefits of the composition be obtained. If it were not heat treated the qualities would be very much inferior.

(To be continued.)

The Automobile Association is organising a petition by the British public to the Prime Minister against the ever-increasing price of motor spirit, and for this purpose is issuing a large number of printed sheets bearing the petition for signature by motor vehicle owners. We are informed that the Auto-Cycle Union, realising how hardly motor cyclists feel the ever increasing cost of motor spirit, is co-operating with the Automobile Association and the Motor Union in presenting the petition.

THE IMPORTANCE OF ACCURACY IN CYLINDER GRINDING.*

Although the importance of accurately-ground cylinders has long been known to those experienced in the building of automobile motors and to the well-informed repair man, it is just beginning to be realised by the average owner.

In order that a motor may work properly and be correctly carburetted, the cylinders must be accurately ground so that the diameter does not vary more than 0·005in. as to roundness, and the hole must be straight and absolutely square with the base of the cylinder in order that the piston may be free to operate without being in a cramped position, in such a case inducing undue friction, noise, and danger of scoring.

In building a high-grade motor, the method of machining is first to bore the cylinder from the rough casting to within ·010 in. to ·015 in. of the finished diameter and then to finish by grinding on one of the special cylinder grinding machines built for the purpose.

It is difficult and almost impossible to bore a cylinder from the rough casting so that the hole is square with the base, because of the tendency of the boring tool to follow the cored hole, and because the inaccuracy of the core invariably leaves the casting thicker on one side than on the other. The grinding wheel will straighten the hole and leave it square with the base, provided the grinding machine is of proper construction and rigid enough to handle the work.

Many of the lower priced motors are built without the final operation of grinding the cylinders, reaming or lapping to make a finished hole being substituted for the grinding. This operation leaves a smooth hole which may measure round, but which is usually not square with the base of the cylinder, and the relative efficiency of the motors thus produced depends largely on chance, as the cylinders may or may not be straight. This explains in some measure why cars of the same make and model are not parallel in performance.

Without an accurate, straight cylinder it is impossible to obtain good compression in a motor, because it is impssible to fit a ring to an out-of-round cylinder or to one which has been enlarged in the top, either by wear or by inaccurate machining. Not alone is the compression affected, but the leakage past the rings is more noticeable on the suction stroke when a certain amount of air is sucked up from the crankcase past the rings and into the combustion chamber, weakening the mixture and causing the motor to miss, especially at idling speds. The first impulse of the driver, when this condition occurs, is to enrich the mixture, which overcomes the difficulty in a measure, but leads to more serious trouble. An excess of raw gasoline is thus introduced into the cylinder and works down past the rings on the compression stroke, thinning the oil and destroying its lubricating qualities and possibly resulting in one or more scored cylinders. This gasoline eventually reaches the crankcase and mixes with the oil, thinning it to such an extent that it is useless for lubricating. This condition is not only found in motors whose cylinders are worn from use, but it is

* *Grits and Grinds.*

often present in comparatively new motors in which the cylinders have been inaccurately bored or reamed.

The popular remedy for this condition, once the car owner becomes aware that it exists, is to install a set of new piston rings, which usually aggravates the condition, because new rings require a long time to wear to a fit in an egg-shaped cylinder, and the only real cure is to send the cylinders to some reliable company which is equipped with accurate, special cylinder-grinding machinery and have the cylinders ground square with the base and fitted with new pistons and properly fitting rings. Care should be taken that the cylinders are not ground on a make-shift grinding machine, but on a machine built for the purpose by manufacturers of long experience in making this class of machinery.

FOREIGN TRADE POSSIBILITIES.

The Department of Overseas Trade, 4, Queen Anne's Gate Buildings, Old Queen Street, London, S.W.1, have supplied us with the following important information issued by the Intelligence Branch of that Department.

TOURING EXHIBITIONS OF BRITISH MANUFACTURES.

We have received some advance notes and regulations relating to certain Touring Exhibitions of British manufacturers, which it is hoped can be organised by the Department of Overseas Trade: It is proposed that these exhibitions should consist of

(1) A Touring Exhibition to the Dominions;
(2) A Touring Exhibition to South America;
(3) A Touring Exhibition to the Far East;
(4) A Touring Exhibition to the United States of America.

It is believed that these exhibitions, which will be on a self-supporting basis, will give manufacturers unusual facilities for showing their products at a comparatively small outlay. For example, on the basis of, say, 500 exhibitors the cost of a tour of the Dominions occupying about two years will be about 200 guineas for a full unit of approximately 10 ft. frontage, and 120 guineas for half such a unit.

The exhibitions will be in charge of officers of this Department who, in co-operation with the Department's overseas officers, will arrange all details for the display of the exhibits to the best advantage in the various towns visited. These officers will furnish trade enquirers with information regarding the articles exhibited, and will endeavour to place them in touch with exhibiting firms either through local agents where such exist or direct where firms have no resident agent.

Every facilty will also be offered to participants to arrange for their direct representation at the exhibitions, but owing to the number of exhibitors tit will be necessary for several of them to combine, either through trades associations or by groups of, say, 20 or 25 firms. All responsibility for representation will rest entirely with the exhibitors, and the fees chargeable do not include any sum on this account.

The first tour to start will be that to the Dominions, which has already been sanctioned, but it is hoped that this will be followed at short intervals by the other three tours to South America, the Far East, and the United States.

In order to complete the organisation at the earliest possible date, it is necessary that some indication should be forthcoming at once as to the amount of support which the exhibitors are likely to receive. If full opportunity is to be taken to hold and develop our export trade, promptitude is essential; otherwise the exhibitions will arrive only to find the markets already being exploited by other nations. It is very desirable therefore that you should be able to give some provisional undertaking as to your participation in the tours, should it eventually be decided to arrange them, to our offices for the tours at the forthcoming Fairs at London, Glasgow and Birmingham, either through your representative on the spot or by a personal visit from some member of your firm.

Further details in pamphlet form will be available by the time the Fairs open, but in the meantime provisional details are given of the Dominions tour, and the other three tours are outlined. You will observe that, should you decide to take part in all the tours, the total cost to your firm would be comparatively slight. For this expenditure your four exhibits would be shown for a period of one to two years in practically every important overseas market. Even with the additional cost of joint representation and cinema advertising the expenditure involved will be but a fraction of what it would cost for a special representative to cover the same ground.

It is proposed that the Dominions tour should start at an early date, and it is therefore especially important that firms who may decide to participate in it should come to a decision as quickly as possible.

The Department is also advised that the purposes of these exhibitions will be furthered by the use of special cinema films showing processes of manufacture in their technical and most appealing aspects. Such films could be shown in advance through a number of towns in the vicinity of the centres at which the exhibitions will open, and will attract buyers to visit them. A note on the possibilities of advertising by means of the cinema is attached.

The Department of Overseas Trade has also under consideration the possibility of establishing show rooms at certain continental centres in connection with their commercial secretariats or Consular offices. These would be available for a series of smaller exhibitions of some 25 or 35 exhibitors, which would succeed each other at intervals of one month or less. Interest would be permanently maintained by the constant changes, and their organisation, advertisement, and development would be the special care of our local officers. The arrangements in the case of these Continental exhibitions will be generally on similar lines.

Before proceeding further with the Continental scheme, which will involve instituting enquiries from commercial, diplomatic and Consular officers as to the availability of suitable accommodation and on other points, it is of great importance to the Department to be able to obtain some estimate of the degree of support which the scheme is likely to secure. It is hoped, therefore, that firms will be able to assist the Department by giving them at the time of the Fair their views on this scheme, as well as in regard to their participation in the larger tours.

THE DEVELOPMENT OF BRITISH TRADE IN CHINA: SPECIAL FACILITIES FOR PUBLICITY.

In view of the importance of developing overseas trade, manufacturers will doubtless note with interest that the British Information Committee for China, which rendered valuable services in that country during the war on behalf of the Allied cause, is continuing the publication of the illustrated newspaper, *Ch'eng Pao* (*Truth*) which was a powerful instrument for propaganda. By means of the *Ch'eng Pao* the Chinese were informed of the mighty part taken by the British Empire in the struggle; and the paper, which was circulated throughout the whole of China, attained a position of considerable influence. It is now being continued as a trade and commercial journal devoted to the furtherance of British interests. It is well printed and illustrated, with an excellent service of world news, China intelligence, and special articles by expert writers on industrial developments in Great Britain and other parts of the Empire.

The labours of the Committee, whose headquarters are at Shanghai, are not so well known outside China as they deserve. The members include, amongst others, representatives of the British Chambers of Commerce and of the China Association in China, and prominent business men. In the early days of the war, this patriotic band of Britons saw German propaganda extremely active, and they determined to counter it. But it was an exceedingly difficult task. The Germans were already in the field. They had established a daily paper in their own language at Tientsin; at Hankow they published a daily printed in English and owned by a German. They also controlled two weekly journals, one in German and the other in Chinese. Shortly before the fateful summer of 1914, they brought out a daily paper at Pekin which had a decided influence on Chinese opinion. In addition to this, extensive publicity organisation newspapers in the vernacular owned by Chinese, received at a nominal fee a service of articles and carefully edited items of foreign intelligence such as Germany desired the people of China to absorb.

Against this complete and highly efficient system of propaganda the Allies had no means of appealing to the Chinese in their own language, and in order to deal with the situation, the British Information Committee—known at the outset and up to the date of the Armistice as the British War Information Committee—came into existence. The *Ch'eng Pao* was started as a fornightly journal. In a comparatively short time arrangements were made whereby the paper was mailed to recommended addresses in all parts of China in accordance with lists supplied by residents in the various districts. As the

work progressed, the system of distribution was strengthened till it was well-nigh perfect; there was no place of importance in the whole of China that was not effectually reached, and the aggregate circulation of the news and pictorial sections of the *Ch'eng Pao* numbered between 9,000,000 and 10,000,000 copies.

At the conclusion of the war, everybody connected with the work felt that it would be a matter for deep regret if the *Ch'eng Pao* were to cease publication altogether. As a war-time journal it had achieved great results. The accuracy of its news had been proved, and it commanded the confidence of its Chinese readers. It had enabled them to realise something of the ideals for which Great Britain entered the war. They had come to see Great Britain in a new and favourable light. The Committee were urged to continue the paper. Thus, the *North China Daily News*, the leading journal in the Far East, in a special article pointed out that "A well-run paper like the *Ch'eng Pao* would do invaluable work in preparing the way before the agents of British firms in fields of which they have not so much as touched the fringe, and there is no doubt that if we neglect such means of developing British trade in China, other nations will not. The ordinary British papers in China cannot give that prominence to purely commercial and industrial subjects which is required. They cannot afford either the space or the staff. A special organ is necessary."

Accordingly, after careful consideration, the British Information Committee decided to go on with their work, and the *Ch'eng Pao* is being produced as a complete and fully equipped newspaper in the Chinese language, devoted to the promotion of British interests. The British Chamber of Commerce at Shanghai has discontinued its Chinese journal and made the *Ch'eng Pao* the organ of the Chambers in China. His Majesty's Government has ordered copies to be sent to the Legations and Consulates for distribution, and British firms in China with full knowledge of local conditions are recognising the value of the paper—the sole British commercial journal in the country—by supporting it with their advertisements.

Fifty thousand copies of the *Ch'eng Pao* are being circulated every fortnight throughout the whole of China, the splendid war-time organisation for the distribution being utilised for the purpose. A certain amount of space is reserved for the business announcements of firms in this country; and in order to faciltate this important department of the work, the Committee have appointed, as their representative in Great Britain, Mr. Henry Barnes, of Overdale, Chelmsford, who will be pleased to hear from manufacturers who are desirous of obtaining publicity for their goods in the China market.

It may be mentioned, also, that the British Information Committee made effective use of the cinema to bring home to the Chinese the nature of modern warfare; and films were shown in many of the principal cities and towns depicting the making of munitions, the training of troops, how the tanks were manœuvered, typical ships of the British Navy, the devastated areas in France, and pictures of the armies behind the firing line on the western front, etc. Now, instead of war films, arrangements have been made to show Britain's effort in peace time, and facilities are offered to British firms to show the Chinese how their goods are produced by means of the film.

Another important medium for publicity under the auspices of the Committee is a large volume now in course of preparation, the "British Trades Directory in Chinese." This is designed to be a comprehensive guide to British manufacturers, agents, shippers, and merchants, with descriptive articles respecting the goods supplied and handled by them. It will consist of about 400 pages, and 10,000 copies are to be distributed to recommended addresses all over China.

BRITISH MOTOR SPIRIT.

One of the most immediate after-the-war problems is that of transport and its cost. And the cost of motor transport occupies a leading place among the factors involved in the problem. The question has been brought to the front by the suddenly threatened rise in the price of petrol, which is reckoned to be, for a first start, at a minimum figure of 8d. per gallon. The question that is agitating the mind of the motorist and the public generally is how can that rise be met competitively with the best prospects of success? The answer is, by developing the various sources of supply on sound lines.

The present main sources are (1) imported petrol; and (2) benzole, a home product. The estimated consumption of petrol for the whole country amounts to 240 million gallons, which can and will be provided by the importers at any price they care to fix; whereas the existing production of benzole at present prices only reaches approximately 20 million gallons. The result at present is that the home consumer is held to ransom by the Oil Combines, while the makers of benzole—a purely British industry, by the way—willing and anxious to come to the rescue, have been hampered by the present absolutely uneconomic figure at which they have been producing that valuable commodity.

It should be explained that benzole was one of the discoveries of the war. In the early days of that struggle the Government besought the co-operation of the coke-ovens owners, gas undertakings, and others, for the purpose of securing a large supply of the commodity, toluole, which is the main ingredient of the high explosive, T.N.T.

During the process of the extraction of toluole, its fellow hydrocarbon, benzole, had to undergo an equally high rectification, which brought out its real value as a propelling agent, a value that had previously been unsuspected when it was less highly-rectified. It may therefore be described as an actual war discovery.

Immediately after the armistice, however, quite a number of the benzole producers ceased to extract this valuable motor fuel, mainly influenced by the business reason that the price obtained by them for carrying out the work was not one which would show a profit on the undertaking. This resulted, as stated already, in a decline of the benzole production by about one-half.

In the meantime, too, other factors were at work in the shape of a general rise in prices of materials and labour. This led in many instances to a loss in this particular section of their business on the part of producers. These increased costs are three times greater than the cost before the war, and here are a few examples to prove this fact:—

- Coal has gone up 300 per cent.
- Wages have risen over 300 per cent.
- The cost of refining benzole has increased 300 per cent.
- The price of wash oil, which is essential to manufacture, has increased 350 per cent.
- Sulphuric acid, also very necessary in the rectification process, has risen 300 per cent.
- Inclusion of between 25 per cent and 30 per cent of toluole in "National" benzole, the market value of which is twice that of benzole.

Other instances of increases could be cited to a weary length.

In addition also to these increased costs of production there has now to be counted a factor affecting the costs of distribution in the shape of an increase in railway rates to the extent of 60 per cent.

Under these circumstances benzole producers are reluctantly compelled to raise the price. Benzole, as from Monday, January 26th, will be 4d. dearer, namely 3s. 1d. instead of 2s. 9d. per gallon.

If the cost of production does not increase it is understood that there is no intention on the part of the Benzole Company to increase their prices out of sympathy with petrol.

This rise, it may be pointed out, is very small, as compared with the enormous rise in costs of production. And, let the public consider how great are the advantages of using benzole as a motor spirit. It is, in the first place, British made; in the second, it is of first grade quality, and the following are some typical results it has achieved under the most searching tests:—

In the A.A. officially-certified 10,000 miles test on a 16-H.P. "Sunbeam" car, the average mileage per gallon of "National" Benzole was 24·57; in the R.A.C. certified non-stop run from London to Edinburgh on a "G.N." car, the average mileage was 59·8; while on an R.A.C. certified one-gallon test, on a 40-50 H.P. "Rolls-Royce," the average mileage was 18·1.

Among the many qualities that will commend benzole as a motor fuel to the public for both personal and commercial transport is the fact that in the coldest weather it does not freeze, owing to the presence in it of the toluole.

Add to this the characteristics of sweet running and good mileage (20 per cent greater than any other motor spirit), then, even at the enhanced price, benzole is cheap as well as efficient.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The London graduates of the Institution of Automobile Engineers are about to renew their pre-war practice, and hold a dinner and concert. The gathering will take place at Anderton's Hotel, on Saturday, April 10th, at 6-30 for 7 p.m., and will be limited to 45 graduates and guests, so that early application should be made. Single tickets will be 10s. 0d. each, and double tickets admitting a graduate and a lady, will be 15s. 0d. each. A very good musical programme is being arranged to follow the dinner.

"THE JOURNAL OF THE INSTITUTE OF METALS." Vol. XXII.; 428 pages and 31 plates. Edited by G. Shaw Scott, M.Sc. (1919: The Institute of Metals, 26, Victoria Street, London, S.W.1. 31s. 6d. net.)

A book which should be in the hands of every metallurgist and engineer is the "Journal of the Institute of Metals," the twenty second volume of which has just made its appearance, and which contains amongst other valuable matter, a verbatim report of the Ninth May lecture by Professor F. Soddy, M.A., F.R.S., on "Radio-Activity," and the communications and discussion at the recent Sheffield meeting, which it will be remembered proved such a great success.

Amongst the many practical papers contributed, there may be noted one on "Season Cracking," by Dr. W. H. Hatfield and Captain G. L. Thirkell, A.I.F., B.Sc., a paper which provoked such an interesting discussion at the autumn meeting, and one by a lady metallurgist, Miss Hilda Fry, and Dr. W. Rosenhain, F.R.S., on "Observations on a Typical Bearing Metal." Dr. F. C. Thompson and Captain F. Orme, M.Met., contribute some valuable notes on "The Constitution and Metallurgy of Britannia Metal," whilst "The Properties and Manufacture of Standard Silver" are dealt with by Messrs. E. A. Smith, A.R.S.M., and H. Turner. Investigations on "The Ternary Alloys of Tin-Antimony Arsenic" form the subject of a communication by Dr. J. E. Stead, F.R.S., and Mr. L. J. Spencer, M.A. Professor C. H. Desch's second report to the Beilby Prize Committee on the "Solidification of Metals from the Liquid State" isa communication touching the fundamentals of engineering work, as is exhaustive paper on "Moulding Sands for Non-Ferrous Foundry Work," contributed by Professor P. G. H. Boswell, O.B.E. Other useful pieces of work include notes by Dr. F. C. Thompson on "Graphite and Oxide Inclusions in Nickel Silver," "The Micro-mechanism of the Ageing of Duralumin," by Dr. Zay Jeffries, of America, and a veritable "classic," by Mr. R. E. Leader, on "The Early History of Electric-Silver Plating."

The volume concludes with an invaluable section, of nearly seventy pages, devoted to abstracts of papers relating to the non-ferrous and allied industries, which have been compiled from the transactions of scientific societies, and the technical press of the whole world. These abstracts will be found indispensable by those who, without undue labour, would keep in touch with recent scientific progress.

The publication, notwithstanding heavy increases in the cost of production, continues to come up to its high pre-war standard, and is published at the offices of the Institute of Metals at 31s. 6d. net.

The Institution of Automobile Engineers.—A meeting of the Scottish Centre of the Institution of Automobile Engineers was held in Glasgow on Monday, February 16th, when Dr. A. H. Gibson, instead of reading his paper on "The Air Cooling of Engines," as presented to the parent body in London, gave an extremely interesting lecture on the general question of air cooling, in the course of which he gave a great deal of fresh information on the subject. The paper has proved to be an exceedingly valuable one, and it is certainly to be hoped that members of the industry will make good use of the perfectly definite information given by Dr. Gibson, and not simply put the paper away on their book-shelves, a point which was strongly urged in the discussion by several of the speakers. The Institution is to be congratulated on having the promise of another paper from Dr. Gibson next session.

Making Old Bolts and Nuts Fit for Reuse.—It has always been the object, says the *Technical Review*, of German railway management to reduce the cost of upkeep, but in the present conditions it is more essential than ever before. The article, which it condenses and translates, is specially concerned with damaged bolts and nuts from the permanent way—these formerly went direct to the scrap heap. The methods for preventing this waste, which have been devised by Mr. Gerz, of Witten, deserve publicity. Bolts in which the thread had become worn were straightened, the defective part cut off, and rethreaded, thus making a perfect bolt of shorter length. The nuts, when rusted on, were cut off, heated in a furnace to loosen them on the bolt, and then retapped. In some cases nuts and bolts can be heated in a gas furnace, so that when hot they can easily be separated. The author says that the processes employed will remind the reader of those invented by Mr. Wegener, in which old bent parts were heated, pressed back to their original shape, and reused. These combined processes have saved the railway management very large sums.

Patent Applications.

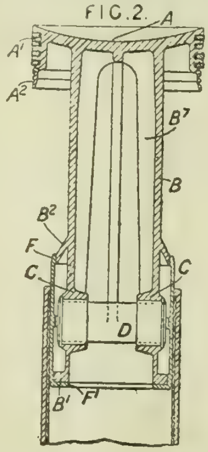
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

PISTONS.

126,061.—H. R. Ricardo, 13, Dartmouth Street, Westminster.—Nov. 23rd, 1916.—In an aluminium etc. piston for an internal-combustion engine, of the type described in the parent Specification, the integral hollow projection B carrying the gudgeon-pin bosses C is formed with a flange B1 to which a flange F1 on the steel, etc., wearing sleeve F is secured by screws or bolts. In the form shown, the sleeve F bears also on a flange

FIG. 2.

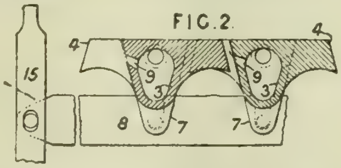


B2 on the projection B and on an intermediate flange, which is interrupted at the bosses C to permit the insertion of the gudgeon-pin. In a modification, the sleeve F is screwed internally to engage corresponding screw-threads on flanges on the projection B, the flanges B1, F1 being also secured together. The gudgeon-pin is preferably free to rotate both in the bosses C and in the connecting-rod end. The projection B has internal flanges B7 which facilitate the conduction of heat, and cooling may be increased by the circulation of air in the space between the head A and the head of the projection B. This intermediate space may also be employed for pumping, the head of the projection B being either smaller than the piston A, or equal, or greater in diameter.

FURNACES.

126,277.—Sherry Water Tube Boiler Co., 810, Lowman Building, Seattle, Washington, U.S.A., (Assignees of J. C. Sherry, 1423, L. C. Smith Building, Seattle, Washington, U.S.A.—March 31st, 1919. Fire-bars are provided with longitudinal air passages 3

FIG. 2.



discharging air through perforations 9 arranged between projections 4 on the sides of the bars. The ends of the projections are inclined to form deflecting-surfaces for the air discharged through the perforations. The bars are mounted in bearings and adapted to be rocked by a lever 15 and bar 8 engaging with lugs 7 on the bars.

REINFORCED-CONCRETE BEAMS.

126,100.—F. Bolton, 25, Victoria Street, London.—Mar. 28th, 1918.—Trough-shaped blocks A, Figs. 1 and 2, are held in alignment

FIG. 4.

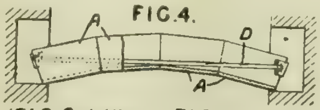
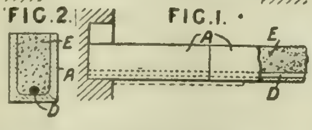


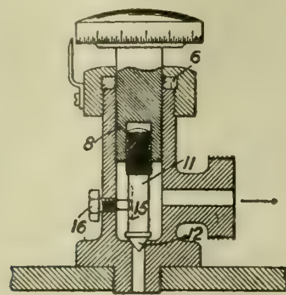
FIG. 2. FIG. 1.



by a tie-rod D with terminal clamping-means and the channelled beam thus formed is filled with concrete E. An arched beam may be made as shown in Fig. 4.

PISTON PACKING.

126,359.—G. Birch, 118, Scott Road, Pitsmoor, Sheffield, and H Humphreys, 37, Melville Road, Barnes, London.—Jan. 10th, 1917.—A packing-ring of the cup-leather type, which is especially appli-

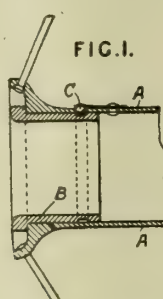


cable for aeronautical internal-combustion engines, is formed with a thickened edge *b*. When an inner ring *c* is nested in the packing-ring the inner ring may be formed with a similar bead *c*1.

BEARINGS.

126,072.—T. Sloper, Southgate, Devizes, Wiltshire.—Nov. 29th, 1916.—A wheel for aeroplanes is fitted at each end with a loose bush B retained in the hub A by a spring-pressed ball detent C,

FIG. I.

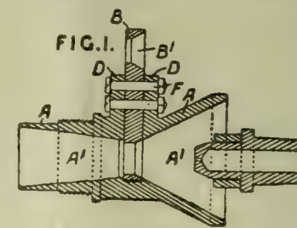


which allows the bush to be removed without the use of a tool. The bush normally rotates on the axle, but if it seizes, the hub rotates on its outer surface.

ATMOSPHERIC GAS BURNERS.

126,412.—Sharp and Preston, and A. Docking, St. Kevin's Engineering Works, Francis Street, Dublin, Ireland.—Mar. 6th, 1918.—In mixing-tube having a construction near its inlet end, the constricted part is made movable so that any one of a series of apertures can be made to register with the passage

FIG. I.

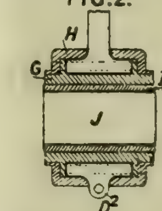


in the mixing-tube. In one form, a disc B, having apertures B1 of varying sizes, is pivoted on lugs D on the mixing tube, and is locked by a bolt F passing through holes in the lugs and one of a series of holes in the disc. The openings in the disc are made cone-shaped at their front ends to form an unknown continuation of the passage A1.

ENGINE CONNECTING-RODS.

126,444.—J. Jarvis, 729, Ormskirk Road, Pemberton, Wigan, Lancashire.—May 6th, 1918.—In a radial-cylinder internal-combustion engine, the connecting rods have segmental feet bearing on a steel bush G formed with side flanges. The master connecting-rod is

FIG. 2.



secured to the bush G and the other connecting-rod ends are retained by caps H. In the case of a three-cylinder engine, the ends of the auxiliary connecting-rods are spaced by a segment D2 which is secured to the bush G and acts as an oil scoop. The bush G may have a phosphor-bronze or other lining I, or alternatively the bush itself may be of phosphor-bronze or similar material.

INDEX TO ADVERTISERS.

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— THE —
Industrial Engineer.

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The Industrial Engineer.

A PRACTICAL MAGAZINE FOR ENGINEERS AND POWER USERS.

Published twice monthly, on the 8th and 22nd days, respectively.

All communications intended for insertion in the Industrial Engineer, *or relating to Editorial matters, should be sent addressed to "The Editors," at our Office, 121, DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

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CONTENTS.

EDITORIAL.

TWO NOTABLE EXHIBITIONS.

Propaganda has been initiated to emphasise the absolute necessity of increased production if we are ever to reduce the abnormal conditions which at present prevail. Sell more and buy less from abroad is the panacea for our present financial difficulty, and if this policy is pursued, then the result will undoubtedly be the dollar at 4·75 to the pound sterling. Too long have we allowed our trade rivals the monopoly of trade Fairs, and one might almost refer to the British Industrial Fair as the best example of reconstructive work that has yet been designed.

Great success has attended, we find, previous Fairs already held, but we venture to think that the present enormous display at the Crystal Palace, London, will produce records of business hitherto undreamt of. Participation in this Fair is confined to British manufacturing firms, and although the venue is the largest exhibition hall in the world, it has proved too small to accommodate the manufacturers who have applied for space.

During the war, the Board of Trade was unable to include trades which were primarily engaged in the manufacture of munitions, but the restriction has now been removed, and, in addition to the trades which participated last year, visitors found sections devoted to jewellery, cutlery, electro-plate, scientific instruments, optical instruments, and export furniture. How large the Fair is may be judged by the fact that the gangways measure no less than $3\frac{1}{2}$ miles, while the stand frontages extend to 5 miles.

From the mechanical or electrical engineers standpoint, there is not a great deal that is of moment, but it must be rememberd that similar Fairs were opened at Birmingham and Glasgow—overlapping being avoided—so that quite a different set of exhibits were to be found at each place. There is no question as to the value of these Fairs. In mere terms of orders they evidence a tremendous success. It would be idle to bewail the fact that we are late in the day, but we certainly agree that extremely rapid strides have been made, and in five years the leeway has been made up. There are infinite trade possibilities in such a Fair as that held at the Crystal Palace. With our new Department of Overseas Trade, our trade commissioners, and our reconstructed consular organisation, there is no reason why in any department we should lose our place. It all, however, comes back to the original plea for greater production. One hears of firms being filled up with orders for a twelve month and more. We recognise the shorter hours, and also the fact that, in consequence, production is very materially reduced. But there is something more. The rate of production per operative hour is less than it was in pre-war days. In spite of the fact that with shorter hours and consequent reduction in fatigue, the operatives in every department of industry are giving less return per hour, indicating a very serious state of affairs. Only by continued propaganda work will it be brought home to the worker that in his hands lies the solution of his present difficulties of high prices. The continued increases in wages means the perpetual rise of all commodities, and a consequent reduction in the purchasing power of any unit of our coinage. We are convinced that a great deal of business that could have been accepted, provided a

pre-war hourly rate of production was in being, has been turned down because manufacturers have been honest enough to notify customers of the impossibility of delivery, or a delivery date so remote as to be out of the question.

Ideal Home Exhibition.

Before describing a few of the exhibits, we should like to refer to the Ideal Homes Exhibition, also held in London at Olympia.

Recently we have been interested in the many schemes of welfare work that have been initiated. Now in the United States, one of the most important features of this work is the provision of suitable houses for the workers. Take any daily paper to-day, and note the cases of ex-soldiers and others living in rooms, in workhouses, even in stables, and like places. The trouble is a grave one. Not only is it extremely hard on those men who have been offering their lives during the war, but it has its bearing upon the question of production also. One firm visited by the writer had orders for many months. They had applications from workers for jobs, and could take on all who so offered, but they had no houses or accommodation of any kind for them. In view of the universal shortage, the house exhibits at the Ideal Homes Exhibition were more than interesting, they were highly important. Any method which will expedite the erection of suitable homes for the people should receive the most earnest attention. There were many such exhibits at Olympia, and it is to be hoped that full advantage will be taken of the opportunities afforded.

In the United States one comes across many wooden houses—perhaps there are more such than of brick or stone—and extremely comfortable they are. Life in the army has proved that wooden houses can be made habitable and comfortable—even with the comparatively rough erections provided—and there is no reason why this form of construction should not be largely adopted.

Exhibits at Ideal Home Exhibition.

An extremely interesting plant was that shown by Winget Ltd. Concrete block making machines and concrete were shown which enabled the Government to carry out a vast programme of constructional working during the war. Now, these machines can be turned to peace-time occupations, and should help to solve the housing problem that is so vital at the moment.

The Vickers Cottage.

Time is the essence of the contract, and Vickers can certainly claim its fulfillment. They showed a cottage erected complete in ten days. The walls of this cottage were constructed of concrete bricks, made on the Vickers Portable Brick machine. The roofing tiles were of concrete interlocking roofing tiles, also made on a portable machine the production of the firm. They are specially water proofed. The internal partitions were made of moler fireproof bricks, while the joinery and carpentry showed evidence of the value of mass production. One could, however, itemise the whole of the constituents of the house in exactly the same way, but the main fact remains, that the house was erected and equipped in ten days, and was an extremely good piece of work.

Bell's United Asbestos Co. Ltd.

This firm showed a cottage constructed from their Hurcan sheets. These sheets or slabs are used in combination with Lovell bricks, and can be quickly assembled. The "Hurcan" slab is stated to differ widely from the ordinary concrete block, as it is impervious to moisture. The asbestos portion is actually combined with the concrete.

The Léan Block System.

The Léan blocks are specially designed to expedite erection and to reduce the amount of skilled labour rquired. In superficial area, 22 blocks equal that covered by 100 ordinary clay bricks. Each block is run upon and into the keyed end of the next. The saving effected in erecting an 8-in. Léan wall is considerable, the cost being less than one-half that of the ordinary 9-in. wall.

Dorman, Long and Co. Ltd.

showed a steel-frame house built on the "Dorlonco" system. The basis of construction is a steel frame encased in expanded metal material (Hy-Rib), sand and cement. Bricks and timber are almost eliminated. Great speed in completion can be obtained by proper organisation. A special advantage is that the steel frame can be erected complete, independent of any other materials used in the construction, and the roof can be covered, if necessary, previous to all internal work.

Ferodo Exhibits

comprise stair-treads made from the well-known Ferodo fabrics. They are made from woven cotton impregnated with chemical bonding agents, which impart to the cotton the durability of metal and increase its original high frictional value. A trial piece has lately been taken up which had been in use over three years, and during this time twenty-eight million people had stepped on to the Ferodo material with both feet.

Self-Contained Lighting Plants.

Quite a number of interesting and ingenious examples of self-contained lighting plants were exhibitd, amongst them being the Lalley Light. It is started with a switch, and stops automatically. The engine is well designed, and apparently well finished. The leading features are extreme simplicity, coupled with strong construction and comparatively low running cost.

"Kaleeco" Wiring System.

Manufactured by Callender's Cable and Construction Co. Ltd., these wires are braided with silk on glacè cotton. They can be supplied braided and compounded for installation in damp places.

British Industries Fair Exhibits.

Generally speaking, the manufactured articles at the Crystal Palace were not of very much moment to engineers. Electrical fittings were perhaps the most prominent. At Birmingham, however, there were quite a number of engineering accessories. In the following account a few of the exhibits are referred to. The city given in parenthesis denotes whether the exhibit was in London or Birmingham.

Messrs. J. H. Tucker and Co. Ltd. (Birmingham),

showed a wide range of accessories for electric lighting and power, which included ironclad gear, switchboards, and switch gear generally. Fuses of different patterns and various sizes from 15 amperes to 1,000


BUILDINGS &
STANDS AT THE
IDEAL HOMES
EXHIBITION.
SIEMENS BROTHERS & Co. LTD.
FERODO LTD
PATENT NON SLIP
LONDON HOUSE
Manufacturers of
BRITISH TIME RECORDERS

amperes were shown, also switches of the firm's "N.K." and "O.K." patterns in various sizes from 15 amperes to 1,000 amperes, and in single, double, and triple pole, single throw, change-over, and other forms. Battery regulating, shunt regulating, and voltmeter switches were also shown. A special feature was a complete standard accumulator switchboard, consisting of ammeters, voltmeter, voltmeter switch, charge and discharge battery regulating switches, automatic battery cut-out, main double-pole switch, and fuses for dynamo and also for lights, mounted on enamelled slate. These boards are for use in conjunction with batteries and lighting sets for country house lighting and similar purposes, and are standardised for 25, 50, 75, 100, and 150 volts, and for 15, 25, 50, 75, and 100 amperes capacity, and are put through the works in quantities ensuring minimum production costs. The "Tucker" patent quick "make" and "break" ironclad switch in two sizes, 25 and 50 amperes, with and without double-pole fuses, was another special feature. Samples of ironclad switches and fuses for house, works, and other industrial purposes were shown in single, double, and triple pole; these varied in sizes from a 5-ampere ironclad and water-tight to 100 amperes, and were of the "turn," "push and pull," and various other types.

Different patterns of ironclad fuses were shown, switches for sunk and surface work, having plain, fluted, and ornamental covers, and china and locked covers. The firm's latest production in flat-type switches, in which both a quick "make" and a quick "break" action is obtained, figured prominently.

Messrs. Stewarts and Lloyds Ltd. (Birmingham),
exhibited types of solid-drawn and lap-welded steel pipes. These included an 84 per cent lap-welded steel pipe with a "Vulcan" joint for water power purposes; also a high-pressure steam pipe for 350 lbs. per square inch working pressure, boiler tubes, a patent long-sleeve welded joint, and various kinds of coils and tramway poles.

The Silent Electric Block Co. Ltd. (London),
showed a number of dials in various sizes all controlled by a half-second master clock of their patent type. The action is magnetically locked, thus obviating all possibilty of overshooting. A one-second master clock, and a master clock provided with means for synchronising by the Post Office time signal, or by the hourly time signal of Standard Time Co., was shown. Many of these clocks have been supplied to the Post Office department.

Messrs. Marconi's Wireless Telegraph Co. Ltd. (London),
had on show their latest ½-kw. station, in which the thermionic valve was used as the oscillation generator; there was a marked absence of any spark set, the valve being used up to 3 kw. The Marconi Scientific Instrument Co. showed a variety of small apparatus suitable for amateur wireless workers. The construction and finish of this apparatus is worthy of comment. The Marconi multi-valve amplifier, with six amplifying valves and a rectifier, was included. The Marconi Osram Co. showed valves up to 1 kw.

The Austin Motor Co. Ltd. (Birmingham),
exhibited various motor accessories and generating plant and a glandless petrol pump in section. The ingenious method by which all glands are done away with and leakage rendered impossible was clearly shown.

Three sizes of generating plant for country house lighting were shown in operation. A feature of special interest was a 5-7 kw. automatic battery booster, which consists of a twin-cylinder engine, 10–11 H.P., four stroke, water cooled, direct coupled to a 5 kw., 46-ampere, 110-volt generator running at 800 revolutions per minute, which is coupled to a battery booster separately excited for an output of $+40/0/=10$ volts, 46/80 amperes. The three machines are mounted on one cast-iron bedplate.

Messrs. Vacuum Oil Co. Ltd. (Birmingham),
The well-known and popular Gargoyle mobiloils were exhibited. The following grades for motor cycle lubrication were shown: Gargoyle mobiloil "A," medium; Gargoyle mobiloil "BB," heavy body; Gargoyle mobiloil "B," extra heavy body; and Gargoyle mobiloil "TT" for racing machines.

Gargoyle mobilubricant, one of the best greases on the market, and Gargoyle clutch oil were also shown.

An interesting lubrication chart of recommendations to motor cyclists as to the correct grade of oil to use was shown at the company's stand.

Messrs. John Heywood Ltd. (London).
The question of dividing large halls, schools, and the like is one of importance. At works provided with dining-rooms it may be often found necessary to cut off one portion and reduce the size for a particular purpose. The above firm have for years specialised in this class of work, and their sliding or folding partitions have been adopted to a considerable extent. In the sliding partitions no hinges are required. The device is simple in construction, and can be carried out in accordance with the architect's design. The partition, when not in use, runs along one of the side walls and occupies little space. A new type partition is made of narrow leaves hinged together. The leaves fold in sets of three, and are not hinged to the walls. Simplicity of construction, ease of operation, and the entire weight supported on floor are the main features of these partitions.

The National Time Recorder Co. Ltd. (London).
This Company showed an excellent variety of time recorders. They make fifteen different models altogether. A special feature amongst these was the Improved Automatic Autograph Time Recorder for office or small works. This recorder is specially intended for a small number of people.

ALUMINIUM INDUSTRY IN GERMANY.

This industry is now passing through a very difficult period. The requirements of the war necessitated the annual production of 40,000 tons, which led to the opening of numerous aluminium works, which (although created at great expense and using steam as a motive power) are likely to have to close their doors. This is more especially the case as foreign works, running for many years past and using a much cheaper and efficient source of energy, are able to produce aluminium which is 51 pfennig chaper per kilo. than German aluminium. Although in pre-war days Germany's consumption of aluminium annually amounted to 10,000 tons, it is calculated in future that she will require not less than 70,000 tons per annum; this will be more especially the case if aluminium is to replace copper in electrolysis. On the other hand, it is thought when the prices of aluminium and copper will also tend to render the use of aluminium compulsory as a substitute for copper during some year to come.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 207.*)

PAPER 3.

Our second paper dealt comprehensively with the general relations between the various plates, their deflections, and the permissible external loads, for all plate springs, and also considered in detail numerous different types of leaf "points," sufficient in variety to cover all of the ordinary commercial springs in use at the present time. This third and, for the present, concluding paper will deal with two of the most important of the remaining questions. These are: first, the "nip" stresses, and, second, the "life" of the plates under the varying stresses produced in the metal when in use.

We have previously mentioned that when a leaf spring is manufactured the leaves are shaped to different curvatures, as indicated by Fig. 32, and this regardless of the number of leaves, their thicknesses, widths, etc. Now, when such leaves are assembled to form a spring, it is patent that each leaf will be deflected more or less, in either a positive or negative—down or up—direction, with the result that there is produced an "internal" stress in each of the leaves comprising the spring. The clear distance between any one plate and the next, measured at the centre, when the plates are placed in contact at the ends, but without pressure, is termed the "nipping distance," or the "nip," and the stresses produced by clamping or bolting up the plates so as to contact at the centre are called "nip stresses." The term "nip" is of English origin, the American spring-maker's shop phraseology being "pull" or "tension"; we ourselves prefer and shall use the English term as being the more expressive.

It will shortly be shown that the nip stresses, acting in conjunction with the stresses produced by the external loads, are of vital importance, for it is the combination of the two stresses, produced by the nip and external load, or the static and dynamic stresses properly combined which determines the life or endurance of each plate in a spring.

The study of the nipping stresses has been almost wholly neglected by nearly every writer who has contributed to the study of the leaf spring, and we have never seen any paper in which the real utility and sometimes even the necessity of nip was pointed out. The existence of the nip stress has been mentioned by Prof. Perry in his "Applied Mechanics," where he says that to overcome the effects of "this objectionable practice the shorter plates should be made thinner." Of course this would reduce the nip stresses, but cannot wholly remove them; neither is it always desirable to do so. Paul Brennier, in his excellent memoir, "Etude sur les Ressorts,"* has recognised the evil effects produced by these internal stresses, but we are reasonably assured that no writer had studied the question in connection with the strength and life of a spring until the advent of the year 1908,† when one of the writers suggested and applied the endurance test to plate springs. The authors take the opportunity here afforded to state that most of the test results mentioned in the present paper were undertaken and carried out in the laboratories of the Sheldon Axle and Spring Co. of Wilkes-Barre, Pa., during the years 1911 to 1916. They are under deep obligations to this company and especially to their vice-president, Mr. Geo. M. Wall, for the many facilities he has afforded them to carry on this work.

* *Bulletin de La Soc. d'Industry Minerale*, April, 1912, to April, 1913.

† See article by J. E. Bishop in the *Australasian Coach Builder and Wheelwright*, entitled "Springs," appearing in the issue of March 15th, 1906, to January 15th, 1908.

At first sight it would appear that the practice of introducing any nip into plate springs is most objectionable; the further consideration of the conditions involved, especially in the operation of automobiles, shows that the nipping of the plates during manufacture is not only desirable but sometimes absolutely necessary. In the case of springs which are never unloaded, the nip is not required, and is certainly undesirable if present in any appreciable amount. For example, in railroad springs, where the vehicles run on a smooth metal track, the nip introduced during manufacture is very slight indeed, being no more than is required to insure that the plates contact properly. On the other hand, for automobiles and motor trucks, it is found, both theoretically and practically, that nip is not only desirable but is in fact a necessity. We shall show in due course that the nipping of the plates increases the endurance of the upper plates in most cases and particularly that of the very

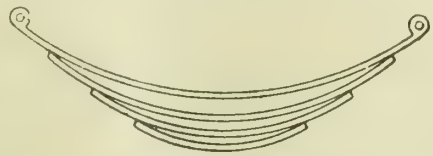

Plate Springs.—Fig. 32.

important master leaf, which is one of the advantages of introducing the internal or nip stresses. Of course, the reduction of the probability of breakage of the main leaf is only obtained at the expense of the other leaves, but they are comparatively of less importance; their breakage does not put the vehicle out of commission as in case of the main leaf breakage; the short plates are much more readily replaced, so that on the whole the advantage gained is considerable.

There is another point of practical importance, namely, that after encountering a sharp obstruction, as often occurs on an ordinary road, the wheels of an automobile frequently leave the road for quite an appreciable time; in such a case the springs may be and often are completely unloaded, even passing quite beyond the unloaded position on the "rebound." Now, if there were no nip in the springs, then, as soon as they reached the free position, the plates would separate, and in coming together again they would "chatter," making an objectionable noise. This fact is well known. One other point—if there were no nip, then, as soon as the spring reached the free position, there would be nothing but the stiffness of the master leaf to take care of the rebound, while with a spring which has been made with nip, the lower plates have an effect in increasing the stiffness of the whole spring for some little distance beyond the free position.*

* See paper entitled "Influence Affecting the Fundamental Deflection of Leaf Springs," by David Landau, in the Transactions of the Society of Automobile Engineers, 1914; also a paper entitled "Apropos des Contre Ressorts," by A. Contet, *La Techn. Auto et Aerien*, July 15th and August 15th, 1912.

We will now consider the intensity of the internal stresses produced by the introduction of the nip during the manufacture of the springs, and it will be found that the previous work given in our first, and especially that in our second paper, will greatly simplify the study of the question.

For the analysis indicated we will let N_n be the stresses our experience has shown that it is best to consider a spring as being built up by the addition of successive plates, commencing with the shortest. Thus, we shall first consider the reaction or pressure resulting from the clamping up into contact of the shortest plate with the adjacent short one or the second short plate; then we will consider the reaction resulting from the clamping of the third short plate *to the two-plate clamped partial-spring first obtained;* and a similar reasoning is then to be continued for all of the plates until the spring is complete.

For the analysis indicated we will let N be the distance between the nth and the $n+1$th plates when they are in contact at the ends without pressure—that is to say the nip distance—and let nip $(1 \;.\;.\;.\; n)-n+1$ be the nip distance between the partial spring of n plates and the free $n+1$th plate.

Now, on referring to the second paper, it will be seen that on adding the second shortest plate to the shortest one, or Plate No. 2 to Plate No. 1, and clamping up to contact at the centre we must then have

$$Y_1 + y_3 = N_1, \text{ or } (B_1 + A_3)\, W_1 = N_1$$

so that the nip pressure between the two plates will be

$$P_1 = \frac{N_1}{B_1 + A_3}$$

we use P for the nip pressure or nip reactions in order to obviate any confusion between the reactions produced by the nips and those produced by the external loads; they are of similar nature, and they act at the same places, but it has been found advisable to use a different symbol for each so as to avoid the possibility of confusion in identification. The pressure or reaction produced when the nth plate is symbol P_n as here used may be defined as the nip added to the $n-1$ plate partial (clamped) spring.

Next, for the nipping reaction between the third plate and the two-plate clamped spring, we must note that the nipping distance will not be N_2, which is the nipping distance only when all the plates are free; the dimension N_2 will have been modified by the deflection of the second short plate produced by clamping it to the shortest plate. Again referring to our second paper, it will be seen that the upward deflection of the second plate, due to its being clamped to the shortest one, will be P_1A_4, and therefore the total nipping distance when the third plate is to be added to the two-plate spring will be $N_2 + P_1A_4$, and it follows that

$$N_2 + P_1A_4 = y_7 + Y_2 = A_4P_2 + B_2P_2$$

from which there is obtained

$$P_2 = \frac{N_2 + P_1A_4}{A_4 + B_2}$$

and similarly, for the nip $(1 \;.\;.\;.\; n)-n+1$, the nipping distance will be

$$N_n + A_{4n-4}P_{n-1}$$

and we shall have

$$N_n + A_{4n-4}P_{n-1} = (A_{4n-1} + B_n)\, P_n$$

from which

$$P_n = \frac{N_n + A_{4n-4}P_{n-1}}{A_{4n-1} + B_n} \quad \ldots\ldots\ldots\ldots(55)$$

and the successive use of this equation (55), with gradually increasing values for n, will determine the internal reactions produced by the nips.

It must be noted that for each step equation (55) gives the value of the nip reaction between the $n+1$th plate and the n-plate clamped spring, when the $n+1$th plate is added; this reaction can be considered in the nature of an external load on the n-plate spring, and therefore the internal reactions between the lower plates will be increased in the same manner as if an external load of the same amount was applied to the partial spring. For example, when the third plate is added to the two-plate clamped spring, the nip reaction between the short and the next plate will be increased by an amount equal to N_2W_1/W_2, or to N_2C_1. The nipping reaction for each additional plate affects all of the lower plates in a similar manner, and the calculations should therefore be carried out in the manner shown by the following example, which is the front spring of the United States Government's Liberty B standardised truck.

This is a ten-plate spring in which the plates have the half-lengths of 5, $7\frac{1}{8}$, $9\frac{1}{4}$, $11\frac{3}{8}$, $13\frac{1}{2}$, $15\frac{1}{2}$, $17\frac{1}{2}$, $19\frac{1}{2}$, $21\frac{1}{2}$ and $21\frac{1}{2}$ inches respectively for the short end. The long end is one inch longer overall, and the lengths of the other plates are all practically in the proportion of $22\frac{1}{2}$, to $21\frac{1}{2}$ to the lengths mentioned. The lower eight plates are all 3 in. × 5/16 in. and the two plates forming the "compound" top plate are each 3 in. × $\frac{3}{8}$ in. The nip distances, when the plates are in contact without pressure are, measuring from the short plate upwards, 1/32, 1/32, 1/16, 1/16, 1/8, 3/16, 5/16, 7/16, and 7/16 inches respectively (these figures were taken from *one* only of the actual springs.

(*To be continued.*)

BENZOLE AS MOTOR FUEL.*

THE 10,000-MILE TEST.

THE result of the 10,000-mile test of benzole as a motor spirit is highly satisfactory. It confirms all that has been claimed for this fuel, and settles at last that important question of its effect upon the engine. The test might have been more conclusive had another car of the same make, weight, and horse-power been run at the same time and over the same route, using petrol, so as to get comparative results under identical conditions. In the main it would have done little more than accentuate the greater power-giving qualities of benzole, but it would have reduced the difference between the two spirits to something like precise data. That difference is known to any motorist who has burned benzole, but it would be a gain to have it worked out accurately under test. It was not the object of the test, however, to demonstrate once again the superior pulling power obtained from the spirit, but to ascertain what effect it had upon the engine. Of that we knew

* *Manchester Guardian*, December 28th, 1919.

little or nothing that was reliable. As the result of the 10,000-mile run we know where we are. The test has established that benzole has no deleterious effect upon the engine, and this clinches all that the advocates of the spirit have said in favour of it. This is further borne out by the results from a similar test with the motor-cycle.

The test was undertaken by the Automobile Association. A standard car of a well-known make was used, and was driven throughout by the makers' own men, and all the time was under the official observation of experts appointed by the Institute of Automobile Engineers and the Automobile Association. In the course of 60 days, over ordinary touring routes, 10,000 miles were run. This is about as much as many motorists do in two seasons, so that it cannot be urged that the car was nursed. The motor spirit conformed to the specification that the National Benzole Association is endeavouring to get recognised as a standard. The average mileage per gallon worked out at 24·57, which, with a car of an average mean weight of 1·8 tons, may be regarded as very good. At its highest the mileage reached 27·71 per gallon over a distance of 115·5 miles, and the lowest was 18·56 over 129·98 miles; whilst a fair average touring speed of 23·46 miles an hour was maintained throughout.

When the engine was dismantled at the close of the test, no measurable wear was detected in any of the parts, nor was there any indication of overheating or discolouration on the polished cylinders. There was some slight sooting of the plugs, one of which had to be cleaned, but was replaced, during the run, whilst some alterations were made to the pilot and main jets. But these are minor matters. Generally, it was found as the result of measurement of the frictional surfaces that the wear throughout was normal.

The Supply Problem.

These are the salient facts that emerge from the test, the details of which are to be found in the official report. They definitely establish that, given a good grade of spirit, benzole is an excellent motor fuel. The question now arises, what next? It is a question of considerable moment to every motorist. What practical steps are now going to be taken to ensure a sufficient supply of the spirit? We need it. The demand for liquid fuel is growing rapidly, and is overtaking, if already it has not reached, the level of present supplies. Indeed, America, which is the main source of supply, can already absorb virtually all she produces, and there are not enough oilfields in sight to compensate for the closing of that market to us, when, if ever, that happens. An alternative spirit is therefore needed, and not merely, as is sometimes urged, to bring down the price of petrol. Benzole is the only present practicable spirit. It has not only the advantage of being home produced, but it is one of many by-products all of which are needed by industry.

The first step is to have a recognised standard of quality, and here it may be said that the test has proved the specification adopted as standard by the National Benzole Association. Nothing below it must be marketed. Development must then be along the lines of supply and distribution, and perhaps the former is the greater problem. Already the demand for benzole is greater than the supply, and this latter must be increased. What can be done by gasworks and coke ovens in the way of production we saw during the war, or, at all events, we learned something about it when there was no longer need for secrecy. The possibilities are enormous. Last year our coal consumption was about 210 million tons, and it is calculated that, treated by up-to-date plant, every ton of coal will yield, among other by-products, $2\frac{1}{4}$ gallons of benzole. As a matter of fact, last year only some $31\frac{1}{2}$ millions were carbonised, and the yield of benzole was no more than 42,160,000 gallons. Of this quantity 14,600,000 tons of coal were carbonised in coke ovens and treated scientifically, all the by-products recoverable being extracted, and the yield of benzole was over 32,162,000 gallons. We are a long way from carbonising every ton of coal that is won, but we are slowly moving towards a less wasteful use of our coal supplies and a wider commercial appreciation of the value of the by-products.

Production, after all, hinges on distribution. It is the motorist, not the manufacturer, who will have to make the market for benzole. It is the strength of the petrol companies that their commodity can be obtained almost anywhere, even in remote villages. They have covered the country with a system of distribution that is a splendid example of efficiency, and benzole will have to be as widely available. Once it is, it will be firmly established as a motor spirit. Already the organisation of supply has been begun. It is uphill work, the more so at present because the call for the spirit is greater than the supply. But that demand should stimulate production. It is a demand that should be stiffened as the result of the recent test, and with an increased output of the fuel its distribution then becomes a relatively easy matter of organisation.

PRODUCER GAS FOR MOTOR VEHICLES.

By D. J. Smith.

(*Continued from page 211.*)

Weight of Producer.

The plant shown in Figs. 8 and 9, Plates III. and IV., which has a grate 12 in. diameter equivalent to 50 H.P., weighs, with its connections, approximately 2·75 cwt., corressponding to a weight of 6 lb. per horse power, though no attempt was made to reduce weight. Retaining cast iron as a cheap and suitable material, the weight of similar powered plants, as shown in Figs. 3 and 4, can be safely reduced to 224 lb. or 4·5 lb. per horse power. If pressed steel were adopted in lieu of cast iron, and aluminium for the blower casing, fuel pipe, etc., the weight could be reduced to under 200 lb. In any case, taking the weight of 6 lb. per horse power, the total weight is so little in proportion to the vehicle weight, that it is really negligible. For larger plants, the weight per horse power can be much reduced, but for vehicle work a 50 H.P. plant is about the maximum likely to be fitted, so that 4·5 lb. per horse power can be taken as a maximum figure. It is possible that at no distant date a very large plant will be at work, weighing under $1\frac{1}{2}$ lb. per horse power.

Determination of the Size of the Producer for Motor Vehicle Work.

The size of a producer is regulated by the consumption of fuel for any given grate area. In stationary producer practice, a consumption of 10 lb. per square foot per hour is a usual figure. Assuming that a 50 H.P. producer is required, and the consumption of fuel (anthracite) is taken at 1·2 lb. per horse power, it will readily be seen that a producer with the necessary grate area could not be accommodated on a vehicle without great loss in carrying capacity. In the producers built on the author's system, a consumption of 80 lb. per square foot of grate area

per hour is possible. To deal with the necessary fuel consumption in this case, a grate diameter of approximately 12 in. is required, and this gives 2 square inches per horse power. This factor can be used for producers between 20 H.P. and 80 H.P. The range of any given size is fairly wide, but if the producer is much too large for an engine, trouble will be experienced on light loads, such as when the engine is running light at slow speed. The suction through the producer is then insufficient to keep the fire at the right temperature, and if the engine is

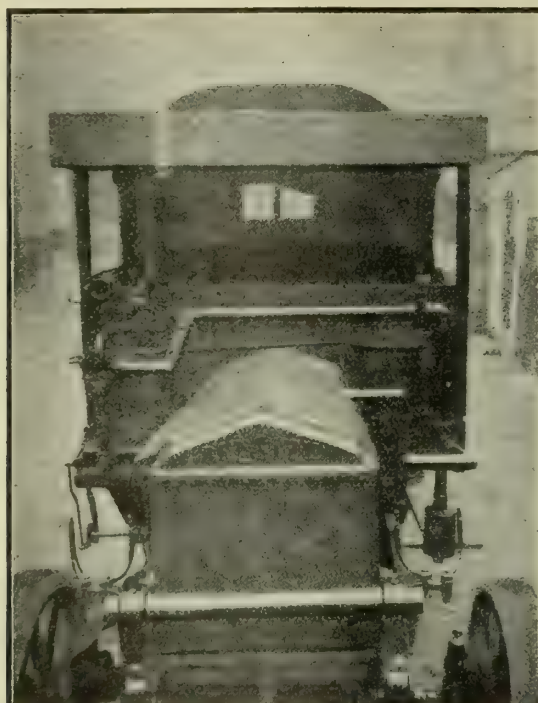

Fig. 8.—Smith Producer shown fitted to a lorry. No encroachment on the loading space or driver's accommodation. The fuel pipe leading from the hopper in the canopy to the producer should be noted.

suddenly speeded up after running slowly for some minutes, the producer may not respond, and the engine will need careful nursing for two or three minutes to get the fire hot again. It is really quicker when this occurs to blow up the producer as when starting up, as 30 to 40 seconds blowing will freshen up the fire sufficiently.

On a motor vehicle the engine is very seldom working up to its full power, so that the producer is generally working well within its limits. If the engine when running light is kept at a fair speed, say, 300 revolutions per minute, no trouble will be experienced if the producer is proportionate to the size of the engine. For short periods, the engine can be set to just turn over, and it is possible to get a much slower running speed on gas than on petrol, but this must not be maintained. For vehicle stops of less than ten minutes, it is not worth while to stop the engine, as the cost of fuel is negligible, but for stops of longer duration than this, the engine should be stopped, as it can be re-started, even after a stoppage of some hours, in three minutes.

Position of the Producer on the Vehicle.

The position which the producer is to occupy on a vehicle is regulated first by the size and weight. With some producers, there is no option; they cannot be put in the most advantageous position, and some part of the useful space on the vehicle must be sacrificed, and access can only be obtained or attention given to the producer by stopping the vehicle. As it is now possible to reduce the size and weight of the producer plant to the figures given by the author, it is not necessary to encroach on any useful space or the driver's accommodation, and the producer can be fitted in the position shown in Figs. 8 and 9, Plates III. and IV., which is generally vacant, and in the few cases where the driver's seat is placed on one side of the bonnet, the producer could be fitted on the other.

The plant will then be under the constant observation of the driver and although practically no attention is required after once starting, he will be able to see that the functions of the producer are being carried out. If necessary, the producer could be put under the bonnet.

The canopy over the driver's head will accommodate a fuel hopper capable of holding enough fuel for a day's run, and here again no useful space is occupied. In fact, unless the fuel hopper is pointed out, it is not noticeable. The water for the producer can be carried in the space usually occupied by the petrol tank under the driver's seat or in the part of the canopy not occupied by the fuel hopper. The pipe conveying the fuel to the producer presents no obstacle to the driver's view, and has a slot running down its length by which he can constantly watch the feed of fuel. Little or no heat is noticeable from the producer when running. The asphyxiation of the drivers, which was often prophesied, has not yet occurred, and if it is remembered that while running there can only be leakage of air into the plant, not leakage of gas from the plant, it will be appreciated that no danger can arise. By carrying the discharge pipe above the canopy, all fumes, gas, etc., when blowing up or standing, can be conducted above the top of the vehicle and dissipated without annoyance. For public service work, this is the only possible posistion for the producer in the author's opinion, as it leaves the whole of the body entirely free, and there is no possibility of any discomfort being caused to passengers, as nothing in connection with the producer need be behind the dashboard.

The Design of Vehicles to Use Producer Gas.

Producer gas as a fuel offers so many advantages that it is essential to consider the design of a vehicle to use this fuel, as if it is used in engines designed for petrol the best results cannot be obtained and its use is likely to prove disappointing. The petrol engine is designed to use a fuel which is relatively expensive, and every designer has made fuel economy his first thought.

While it is necessary to consider economy, even with producer gas, it is by no means such an important item as it is with petrol, and the advent of a cheap fuel serves, in the opinion of the author, as an opportunity to introduce a type midway between

Fig. 9.—Showing method of drive from the engine to the producer Note the freedom of access to the engine is not interfered with.

the present steam and petrol vehicles, having the low upkeep and reliability of the former with most of the advantages of the latter, such as large radius of action, etc., with a fuel cost only a fraction of that of either.

The chief alterations would be in the design of the engine, and the author proposes to deal with this only. Using a cheap fuel, the need for a small high speed engine for commercial work vanishes to a large extent, and it is possible to consider a large comparatively slow running engine having the long life and low

upkeep cost of a stationary engine. The increase in weight would not be considerable, and it should be noted that the author in the comparison in running costs between petrol, steam, and producer gas vehicles has allowed 10 cwt. for the increased weight of such a vehicle, including the producer. This increase would cover the weight of the larger engine also, but not of any increase in the strength of the other parts of the vehicle, as doubtless the widest application of producer gas would be to vehicles which may be termed medium-built commercial vehicles, and differing only from the present petrol lorries in having an engine designed to use this fuel.

An example of what the author has in mind in heavier vehicles is the action now being taken by a well-known firm, which is fitting the chassis of a steam lorry with a gas engine and his producer. This is a combination of well-tried and proved units, and the result of the assembly should prove very satisfactory and allow of heavy loads being conveyed at a lower cost than ever before on common roads with the disadvantages of short water range and heavy fuel consumption of the steam vehicle abolished. These are, however, matters for the designer to work out, but the engine details include no experimenting.

A higher compression, with a half compression device, as used on many stationary engines and on some makes of petrol engines, is essential. A pressure of 120 lb. to 130 lb. by gauge would be necessary to obtain a fair economy with producer gas. An increase of 25 per cent in cylinder dimensions with a reduction in speed to a maximum of, say 700 revolutions per minute, would not add unduly to the weight of or space occupied by the engine, and should materially increase the life if the engine were substantially designed. The author has in mind a 4-cylinder vertical stationary engine $6\frac{1}{2}$ in. diameter by $7\frac{1}{2}$ in. stroke giving 43 B.H.P. on producer gas at 600 revolutions per minute. This engine ran over 15,000 hours without renewal of any working parts, and sometimes ran 144 hours without stopping. At 10 miles per hour this would correspond to 150,000 miles. In the heavy slow-speed stationary engines, such records as the above are easily outdistanced, but this is not a type which could be used for vehicle work. The producer could be covered by the bonnet, the scrubber being situated behind the radiator with the fan in between. This would give a compact power plant and still allow of free access to the engine.

The use of the high compression necessary for producer gas renders the engine unsuitable for use with petrol, but the author does not consider this a serious drawback, as it is not likely that petrol would ever require to be used, as one at least of the fuels suitable for the producer would be obtainable practically everywhere and manufacturers would no doubt, for vehicles up to three tons, adhere to a standard chassis and fit different engines according to the fuel to be used.

The Use of Producer Gas on Petrol Vehicles.

Owing to the very great saving possible in fuel cost by the use of producer gas, many existing petrol vehicles will no doubt be adapted for its use, and unless this is properly done, the results will be disappointing, if not absolutely unsatisfactory. It is no longer, as the author has demonstrated, a matter of doubt as to whether a producer can be so reduced in size and weight and suitably modified as to allow it to be used for vehicle work. To adapt it for use with an engine designed for quite a different fuel is another matter. With most makes and types of commercial vehicles, the problem resolves itself into one of power, if gas from anthracite or coke is used. Alterations to engines are seldom satisfactory, and the author is chary of advising this course. Assuming, however, that no alteration in the engine is made, there is a loss of power of anything up to 20 per cent, varying with the design of engine, by using producer gas from anthracite or coke in place of petrol. With a high-powered vehicle having a relatively low gear ratio, this may not be serious, but with others, where the engine power is comparatively low in proportion to the gross load or the gear ratio is bad, it might be impossible to use producer gas if the vehicle had to perform the same work as on petrol.

An instance may be given of two vehicles of different make, both rated at the same carrying capacity, one having an engine of 108 mm. diameter by 150 mm. stroke and the other 150 mm. diameter by 160 mm. stroke, the gear ratios being almost identical. If the vehicle is chain driven, it may be possible to fit smaller pinions on the countershaft, and thus, to an extent, negative the loss in power, but at the sacrifice of speed. With vehicles having a bevel or worm-driven rear axle, no alteration is generally possible, so that the loss of power must be accepted unless some alteration can be made in the engine or gear box. Some advantage would be obtained by increasing the compression, and a new set of dome-topped pistons is the best method of obtaining this. In some enginess it is possible to fit new cylinders of larger bore, the compression being also increased. This is an expensive matter, and only possible in a few cases. A new and larger engine is the only remedy with many vehicles, as they are underpowered on petrol. This may seem a very expensive alternative, but it must be remembered that by the use of producer gas, it has been found possible to save over £30 in fuel for 1,000 miles running and at this rate a new engine would prove a very good investment.

With many makes, it is possible to instal producer gas without alteration and for the vehicle to perform its normal work with only a slight loss in speed over a give-and-take road, while in level districts producer gas could be used without any difficulty on any vehicle designed for petrol.

The author considers, however, that where it is intended to use producer gas on a petrol vehicle prepared peat should be used as fuel, reserving anthracite, coke, and the more readily obtained fuels for vehicles designed for use with producer gas. The quantity of peat required is not large, and it would very soon be generally obtainable if a demand existed for it. In any case, no difficulty would be met with in getting stocks to be held at the vehicle garages, and as a supply for a 200 miles run can be readily carried, inability to get this on the road would not present a serious difficulty, especially as, in the case of a shortage, the vehicle could always be run on anthracite, coke, or charcoal. Peat could, of course, be used for vehicles designed for producer gas, and if obtainable at the price quoted to the author, would be preferable, but the reason for advocating this fuel, especially for vehicles designed to use petrol, will be made clear by the details given under "Fuels" in this paper, and by the fact that it almost entirely removes the difficulty of loss of power caused by using gas from anthracite and coke in a petrol engine.

(To be continued.)

BOILER TESTS AND "EQUIVALENT EVAPORATION."

By Edward Ingham, A.M.I.Mech.E.

Confusion of Terms.

The steam plant engineer who takes an intelligent interest in current engineering literature is constantly being confronted with the terms, "factor of evaporation," and "equivalent evaporation." Much confusion exists in regard to the true meaning of these terms, and to calculate their values for any particular case appears to be a matter of considerable difficulty to the average engineer-in-charge. Hence, it is thought the following explanation will prove useful.

A Common Basis.

In comparing the results of various boiler evaporative tests, it is necessary to reduce them to a common basis. It is obviously impossible to compare the performances of two boilers if the temperature of the feed water and the pressure of the steam generated are not the same in the two cases. Hence, it is customary to adopt a certain standard of comparison, and the standard adopted is called the "equivalent evaporation."

The Factor of Evaporation.

Before finding the equivalent evaporation, it is convenient to find what is called the "factor of evaporation"; this may be defined as the ratio of the weight of water evaporated "from and at 212 deg. Fah." to that evaporated with the same quantity of heat at the temperature and pressure of the steam. This definition introduces another term which is not always clearly understood, viz., "from and at 212 deg. Fah." By this is meant that steam at a temperature of 212 deg. Fah. is produced from water at the same temperature. Thus, if water at 212 deg. Fah. (which, of course, is the temperature of the boiling point under atmospheric pressure) be gradually evaporated into steam at the same temperature and pressure, then the water is said to have been evaporated "from and at 212 deg. Fah."

Referring again to the definition of "factor of evaporation," it may be further explained that the factor shows the ratio of the number of pounds of water which would be evaporated at 212 deg. Fah. by a certain quantity of heat (assuming the water to be at a temperature of 212 deg. to commence with), to the number of pounds evaporated (by the same quantity of heat) from the feed temperature into steam at the temperature corresponding to the pressure in the boiler.

The factor of evaporation, which may be denoted by F, is easily found thus:—

$$F = \frac{H}{\text{Latent heat of steam at 212 deg. Fah.}} = \frac{h + xL}{966},$$

where H = the total heat in B.Th.U.s required to evaporate 1 lb. of water at the feed temperature into steam at the boiler pressure.

h = Sensible heat.

x = Dryness fraction of the steam produced.

L = Latent heat of the steam at the actual temperature.

It should be noted that the heat required to evaporate 1 lb. of water "from and at 212 deg. Fah." is the latent heat of steam at 212 deg. Fah., *i.e.*, at atmospheric pressure, and this is equal to 966 B.Th.U.s of heat.

Equivalent Evaporation.

The other term, "equivalent evaporation," may be defined as "the number of pounds of water which would be evaporated into steam, assuming the feed water and the steam both to be at 212 deg. Fah., instead of at the actual temperatures." In other words, it shows how many pounds of water would have been evaporated per pound of coal, say, if the feed and the steam temperatures had both been 212 deg. The actual quantity of water evaporated per pound of coal is, of course, less than the equivalent evaporation, because the feed temperature is less than 212 deg., whilst the temperature of the steam is greater, and hence more heat is required for the evaporation of each pound of water.

If W = lbs. of water evaporated under test, per pound of coal, the equivalent weight evaporated "from and at 212 deg. Fah.," or the equivalent evaporation, E = W × F, where F is the factor of evaporation.

An actual example will serve to make the foregoing remarks quite clear.

Example.—A certain boiler, on being tested, is found to evaporate per pound of coal, 7·3 lb. of water at 60 deg. Fah. into wet steam at a gauge pressure of 133 lb. per square inch (corresponding temperature, 357 deg.). The dryness fraction of the steam is ·85. Find the factor of evaporation, and the equivalent evaporation.

The factor of evaporation, $F = \frac{h + xL}{966}$, where h is the sensible heat, x the dryness fraction, and L the latent heat of 1 lb. of steam at 133 lbs. pressure.

$h = 357 - 60$, $x = {\cdot}85$, L = (from steam tables) 862 B.T.U.s.

$$\text{Hence } F = \frac{(357 - 60) + {\cdot}85 \times 862}{966} = \frac{297 + 733}{966} = 1{\cdot}065.$$

The equivalent evaporation, E = W × F, where W = the number of pounds of water actually evaporated under test, per pound of coal. (This is, of course, obtained by dividing the total pounds of water evaporated during the test by the number of pounds of coal burnt.)

We see from these figures that if the temperature of the feed water and the temperature of the steam had been both 212 deg. Fah., instead of respectively 60 deg. and 357 deg., there would have been produced 1·065 times 7·3 lb. of dry steam, *i.e.*, 7·78 lb. of dry steam, instead of only 7·3 lb. of very wet steam at 357 deg. Fah.

Let us now compare the performance of this boiler with that of another which produced, say, 7½ lb. of dry steam at 100 lb. gauge pressure, per pound of coal, from water at 120 deg. Fah. It is necessary to reduce this result to the common standard, *i.e.*, to find the equivalent evaporation, when the two performances can be readily compared.

The factor of evaporation, $F = \frac{h + xL}{966}$, where the letters represent the quantities already specified.

Now $h = 338 - 120 = 218$, the figure 338 being the temperature corresponding to the pressure of 100 lb. per square inch. The dryness fraction $x = 1$, since the steam is dry. L (from steam tables) = 876.

$$\therefore F = \frac{218 + 1 \times 876}{966} = \frac{1094}{966} = 1{\cdot}133.$$

Now, equivalent evaporation, E = number of pounds of water actually evaporated under test × factor of evaporation

$$= 7\tfrac{1}{2} \times 1{\cdot}133 = 8{\cdot}5.$$

This boiler, therefore, would evaporate 8·5 lb. of water at 212 deg. Fah. into steam at the same temperature. In the previous case, we saw that the boiler would evaporate 7·78 lb. of water "from and at 212 deg. Fah."

The performance of the second boiler is consequently better than that of the first.

COAL CONSERVATION AND ELECTRIC POWER SUPPLY.*

Introduction.

Having in my previous lecture discussed the question of the carbonisation of coal particularly in relation to public gas supplies, I propose to devote this one to a consideration of the equally important problem of public power supplies.

In the opinion of many competent judges, the question of increasing and reorganising the supplies of power for industrial purposes is one of the most important problems which the country will have to undertake during the coming decade of reconstruction. I use the word "decade" advisedly, because the work of reorganisation will not be accomplished in so short a time as a year or two; but it may be expected that those of us who may be alive in 1930 will then see in operation a comprehensive scheme for public supply and distribution on co-operative lines, so organised and administered that every power user

* Lecture delivered before the Royal Society of Arts by William Arthur Bone, D.Sc., Ph.D., F.R.S., professor of Chemical Technology at the Imperial College of Science and Technology, London

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 71 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 1 10	12 2 20	0 19 0 2	1 5 1 12	1 11 2 22	1 18 0 4	2 4 1 14	2 10 2 24	2 17 0 6	0
1	0 2 15	6 3 25	13 1 7	0 19 2 17	1 5 3 27	1 12 1 9	1 18 2 19	2 5 0 1	2 11 1 11	2 17 2 21	1
2	1 1 2	7 2 12	13 3 22	1 0 1 4	1 6 2 14	1 12 3 24	1 19 1 6	2 5 2 16	2 11 3 26	2 18 1 8	2
3	1 3 17	8 0 27	14 2 9	1 0 3 19	1 7 1 1	1 13 2 11	1 19 3 21	2 6 1 3	2 12 2 13	2 18 3 23	3
4	2 2 4	8 3 14	15 0 24	1 1 2 6	1 7 3 16	1 14 0 26	2 0 2 8	2 6 3 18	2 13 1 0	2 19 2 10	4
5	3 0 19	9 2 1	15 3 11	1 2 0 21	1 8 2 3	1 14 3 13	2 1 0 23	2 7 2 5	2 13 3 15	3 0 0 25	5
6	3 3 6	10 0 16	16 1 26	1 2 3 8	1 9 0 18	1 15 2 0	2 1 3 10	2 8 0 20	2 14 2 2	3 0 3 12	6
7	4 1 21	10 3 3	17 0 13	1 3 1 23	1 9 3 5	1 16 0 15	2 2 1 25	2 8 3 7	2 15 0 17	3 1 1 27	7
8	5 0 8	11 1 18	17 3 0	1 4 0 10	1 10 1 20	1 16 3 2	2 3 0 12	2 9 1 22	2 15 3 4	3 2 0 14	8
9	5 2 23	12 0 5	18 1 15	1 4 2 25	1 11 0 7	1 17 1 17	2 3 2 27	2 10 0 9	2 16 1 19	3 2 3 1	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	5·91	11·83	17·75	23·66	1 1·58	1 7·50	1 13·41	1 19·33	1 25·25	2 3·17	2 9·08	2 15	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 71 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 3 1 16	6 6 3 4	9 10 0 20	12 13 2 8	15 16 3 24	19 0 1 12	22 3 3 0	25 7 0 16	28 10 2 4	0
10	0 6 1 10	3 9 2 26	6 13 0 14	9 16 2 2	12 19 3 18	16 3 1 6	19 6 2 22	22 10 0 10	25 13 1 26	28 16 3 14	10
20	0 12 2 20	3 16 0 8	6 19 1 24	10 2 3 12	13 6 1 0	16 9 2 16	19 13 0 4	22 16 1 20	25 19 3 8	29 3 0 24	20
30	0 19 0 2	4 2 1 18	7 5 3 6	10 9 0 22	13 12 2	16 15 3 26	19 19 1 14	23 2 3 2	26 6 0 18	29 9 2 6	30
40	1 5 1 12	4 8 3 0	7 12 0 16	10 15 2 4	13 18 3 20	17 2 1 8	20 5 2 24	23 9 0 12	26 12 2 0	29 15 3 16	40
50	1 11 2 22	4 15 0 10	7 18 1 26	11 1 3 14	14 5 1 2	17 8 2 18	20 12 0 6	23 15 1 22	26 18 3 10	30 2 0 26	50
60	1 18 0 4	5 1 1 20	8 4 3 8	11 8 0 24	14 11 2 12	17 15 0 0	20 18 1 16	24 1 3 4	27 5 0 20	30 8 2 8	60
70	2 4 1 14	5 7 3 2	8 11 0 13	11 14 2 6	14 17 3 22	18 1 1 10	21 4 2 26	24 8 0 14	27 11 2 2	30 14 3 18	70
80	2 10 2 24	5 14 0 12	8 17 2 0	12 0 3 16	15 4 1 4	18 7 2 20	21 11 0 8	24 14 1 24	27 17 3 12	31 1 1 0	80
90	2 17 0 6	6 0 1 22	9 3 3 10	12 7 0 26	15 10 2 14	18 14 0 2	21 17 1 18	25 0 3 6	28 4 0 22	31 7 2 10	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	31 13 3 20	63 7 3 12	95 1 3 4	126 15 2 24	158 9 2 16	190 3 2 8	222 7 2 0	254 1 1 20	285 15 1 12	316 19 1 4	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 70 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 1 0	12 2 0	0 18 3 0	1 5 0 0	1 11 1 0	1 17 2 0	2 3 3 0	2 10 0 0	2 16 1 0	0
1	0 2 14	6 3 14	13 0 14	0 19 1 4	1 5 2 14	1 11 3 14	1 18 0 14	2 4 1 14	2 10 2 14	2 16 3 14	1
2	1 1 0	7 2 0	13 3 0	1 0 0 0	1 6 1 0	1 12 2 0	1 18 3 0	2 5 0 0	2 11 1 0	2 17 2 0	2
3	1 3 14	8 0 14	14 1 14	1 0 2 14	1 6 3 14	1 13 0 14	1 19 1 14	2 5 2 14	2 11 3 14	2 18 0 14	3
4	2 2 0	8 3 0	15 0 0	1 1 1 0	1 7 2 0	1 13 3 0	2 0 0 0	2 6 1 0	2 12 2 0	2 18 3 0	4
5	3 0 14	9 1 14	15 2 14	1 1 3 14	1 8 0 14	1 14 1 14	2 0 2 14	2 6 3 14	2 13 0 14	2 19 1 14	5
6	3 3 0	10 0 0	16 1 0	1 2 2 0	1 8 3 0	1 15 0 0	2 1 1 0	2 7 2 0	2 13 3 0	3 0 0 0	6
7	4 1 14	10 2 14	16 3 14	1 3 0 14	1 9 1 14	1 15 2 14	2 1 3 14	2 8 0 14	2 14 1 14	3 0 2 14	7
8	5 0 0	11 1 0	17 2 0	1 3 3 0	1 10 0 0	1 16 1 0	2 2 2 0	2 8 3 0	2 15 0 0	3 1 1 0	8
9	5 2 14	11 3 14	18 0 14	1 4 1 14	1 10 2 14	1 16 3 14	2 3 0 14	2 9 1 14	2 15 2 14	3 1 3 14	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	
Weight.	0 5·84	0 11·68	0 17·52	0 23·36	1 1·20	1 7·04	1 12·88	1 18·72	1 24·56	2 2·4	2 8·24	2 14	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 70 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 2 2 0	6 5 0 0	9 7 2 0	12 10 0 0	15 12 2 0	18 15 0 0	21 17 2 0	25 0 0 0	28 2 2 0	0
10	0 6 1 0	3 8 3 0	6 11 1 0	9 13 3 0	12 16 1 0	15 18 3 0	19 1 1 0	22 3 3 0	25 6 1 0	28 8 3 0	10
20	0 12 2 0	3 15 0 0	6 17 2 0	10 0 0 0	13 2 2 0	16 5 0 0	19 7 2 0	22 10 0 0	25 12 2 0	28 15 0 0	20
30	0 18 3 0	4 1 1 0	7 3 3 0	10 6 1 0	13 8 3 0	16 11 1 0	19 13 3 0	22 16 1 0	25 18 3 0	29 1 1 0	30
40	1 5 0 0	4 7 2 0	7 10 0 0	10 12 2 0	13 15 0 0	16 17 2 0	20 0 0 0	23 2 2 0	26 5 0 0	29 7 2 0	40
50	1 11 1 0	4 13 3 0	7 16 1 0	10 18 3 0	14 1 1 0	17 3 3 0	20 6 1 0	23 8 3 0	26 11 1 0	29 13 3 0	50
60	1 17 2 0	5 0 0 0	8 2 2 0	11 5 0 0	14 7 2 0	17 10 0 0	20 12 2 0	23 15 0 0	26 17 2 0	30 0 0 0	60
70	2 3 3 0	5 6 1 0	8 8 3 0	11 11 1 0	14 13 3 0	17 16 1 0	20 18 3 0	24 1 1 0	27 3 3 0	30 6 1 0	70
80	2 10 0 0	5 12 2 0	8 15 0 0	11 17 2 0	15 0 0 0	18 2 2 0	21 5 0 0	24 7 2 0	27 10 0 0	30 12 2 0	80
90	2 16 1 0	5 18 3 0	9 1 1 0	12 3 3 0	15 6 1 0	18 8 3 0	21 11 1 0	24 13 3 0	27 16 1 0	30 18 3 0	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	
Weight.	31 5 0 0	62 10 0 0	93 15 0 0	125 0 0 0	156 5 0 0	187 10 0 0	218 15 0 0	250 0 0 0	281 5 0 0	312 10 0 0	Weight.

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

in the country will have the right to participate, according to the magnitude of his requirements, on the same terms and conditions as all others. If such a scheme can be devised and put in operation, there is no doubt that power production will, on the whole, be much more efficient than it has been in the past, and that important industrial and social consequences will follow.

The Distribution of Power.

Notwithstanding the fact that every factory or workshop in the country requires power in some form or other, and that more than 97 per cent of such power has been derived, directly or indirectly, from coal, it may seem strange that so little has hitherto been done in the way of generating power co-operatively. There are installed throughout the Kingdom engines of various sorts (but mainly steam engines) of a total nominal capacity of somewhere between 10 and 15 million horse power. The 1907 Census of Production (which are the latest figures available) accounted for 10 million horse power (exclusive of railway locomotives) in the factories throughout the Kingdom. The distribution of this power was somewhat as follows:—

25	per cent	at mines and quarries.
20	,,	at iron, steel, engineering and shipbuilding works.
20	,,	in textile and clothing factories.
18	,,	in public utility services.
17	,,	in all other industries.
100		

Again:—

91·2	per cent	were steam engines (5 per cent turbine, 86·7 per cent reciprocating).
6·4	,,	internal-combustion engines.
1·7	,,	water-power machines.
0·7	,,	other kinds of machines.
100		

Of the total capacity of prime movers, 26 per cent was associated with electrical plants (*i.e.* dynamos generating electricity), and about two-thirds of the latter were engaged in public utility service. The total amount of electricity annually generated in the country in the year 1907 was 2,388 million kilowatts per annum (=273,000 kw. hrs.), of which 1,495 millions, or about 62·5 per cent, were generated in connection with public utility services.

From the foregoing figures it may be concluded (as regards the year in question):—

(*a*) That "public utility plants" were practically all electric plants;

(*b*) That the average load factor on the latter was only about 16 per cent, for

Kw. hrs. generated = 170,000

Capacity of dynamos in operation
= 1,052,783 kw. hrs.

Origin of the Present Individualistic Basis of Power Generation.

The individualistic basis upon which practically the whole of the mechanical power was generated in this country during the nineteenth century was the outcome of the natural limitations under which the steam boiler and engine laboured until they could be associated with the dynamo, which was invented and developed much later than the steam engine. The steam generated in a boiler cannot be carried more than a very short distance without total loss of its energy by condensation; so that the engine must be in close proximity to the boiler, and the transmission of power from the engine by shafting imposes a similar limit on the other side. Consequently, not until either the gas engine or the dynamo had been sufficiently developed to make them reliable and efficient commercial machines, was it at all possible to propose any scheme of *co-operative* power production and distribution; and by that time the individualistic basis had become so firmly rooted that men's minds hardly contemplated any other.

Before the advent of the gas engine or the dynamo, all coal consumed for power production in steam plants had to be conveyed to each particular factory using the power. And it was to the demands for cheap and rapid transport of coal which arose between 1750 and 1850 that we owe the inception and development first of all of our canals and afterwards our great railway system. For (as Jevons remarked "until coal supplied the purpose, there was not spirit enough in this country to undertake so formidable a work as a canal," and George Stephenson used to say that his locomotive engine was destined to bring forth the strength of Britain lying in her coal and iron beds.

Hence, in those times, the system of power distribution necessarily took the form of conveying the raw coal to each factory, where its potential energy was transformed into mechanical power *viâ* steam boiler and engine; the power was then distributed over the factory through shafting.

With the advent of the internal-combustion engine, however, it became possible to utilise gas from the public mains for power production. And since gas can be distributed over considerable areas at a comparatively small cost, this opened up the first prospect of "collective" power arrangements, at least so far as small power users were concerned. Such a system has certain obvious limitations, and it does not get rid of the necessity of having the power generator (*i.e.* the engine) in close proximity to the place where the power is used.

It was the invention and development of the dynamo and electric motor that finally solved the problem, and made it possible, at the beginning of the twentieth century, to organise big public power schemes on the principle that the power required in a given industrial area shall be generated at the particular place or places (within or without it) where it can be most economically produced. Thus electric power is produced from falling water at Niagara and distributed through cables to Toronto and other places in Ontario; whilst, in this country, the North-East Coast Electric Power Scheme affords a good example of how the energy of coal can be similarly distributed from a limited number of large central generating stations.

The Advantage of Co-operative Power Undertakings.

If it be agreed that power may be most efficiently applied to industry by the medium of electricity (I am making this assumption because I have no time to argue it), then undoubtedly there are great advantages to be gained in the way of cheap production by the co-operation of consumers with a properly organised electric power undertaking operating over a large industrial area. And probably no other European country is so well adapted as our own for such co-operative schemes, because of the

compactness of our great industrial areas, the densities of their population, and their proximity to the coal fields. In every large industrial area there are factories normally working during the day only; others must of necessity work both night and day without ceasing. In some cases, the power requirements are fairly uniform throughout the day's run; while in others the requirements are subject to large and abrupt variations. Everywhere there are enormous energy losses continuously going on which the individual manufacturer is either unable to utilise effectually himself or about which he is indifferent.

Supposing (1) that the manufacturers in such an area, instead of maintaining a large number of independent (and probably inefficient) power stations of comparatively small sizes, were to co-operate in a well-organised electrical power scheme, whereby all the separate factories, with their variable demands, are linked up with a few large and efficient power stations, suitably situated in regard to coal supplies, and equipped with the latest generating machinery in considerable units; and (2) that the power undertaking is prepared not only to sell electrical energy, but also to purchase surplus gas, waste heat, and exhaust steam from any of its customers, and convert the same into electrical energy: it is fairly obvious that in such circumstances, greater economies could be achieved by reasonable co-operation than would be possible under any purely individualistic scheme.

(To be continued.)

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

(Continued from page 125.)

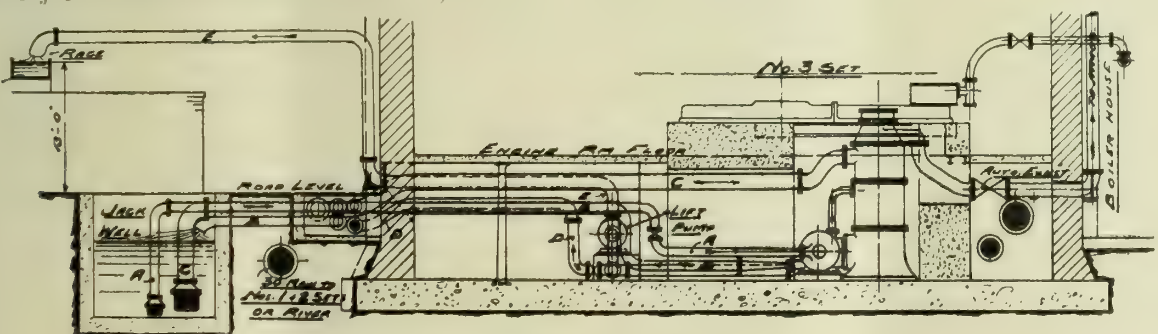
Turning now to the sets 3 and 4 shown on the plan and sections, Figs. 88, 91, and 92 respectively, these are the same output as sets 1 and 2, viz., 3,000 k.w., but have jet instead of surface condensers, sufficient space not being available in the basement to accommodate the latter type.

As will be seen from the plan, No. 3 set was a "tight fit"; only just enough room has been obtainable for the motor, air, and extraction pumps, starters, etc.; in fact, a portion of the foundation of the Yates and Thom set had to be scalloped out to permit of access past the motor; also a slice required cutting away from the electric end of this foundation to allow for a passage through. This portion will be seen dotted on the plan (Fig. 88). I have indicated on this drawing the new concrete foundation work which was necessary "mottled" or shaded rather darker than the existing concrete foundations, to show at a glance the new work. It will be noticed that only a very small portion of No. 3 bedplate rests on existing foundations; new walls, with the end one provided with an archway or opening for passage of injection and discharge pipes, were built.

The turbine and generator bedplate was carried on 14 in. × 16 in. R.S. joists over the opening occupied by the condenser, in a similar manner to Nos. 1 and 2 sets; the span for No. 3, as will be seen, being some 2 ft. wider.

A little more breathing room was found possible round the condenser pumps and motor in the base for No. 4 set, the only new foundation work, it will be noticed, being the turbine end and side walls, the main bedplate in this set being carried by transverse steel joists resting on the side walls, the turbine end of the bedplate resting directly on the solid concrete for a length of about 3 ft. 6 in. Archways were formed in these side walls to admit motor and allow for access, as will be seen from the view taken on K.K., Fig. 92. For facility in following the various pipe runs, I have given the different pipes letters, and have referred to these in a note shown on the plan Fig. 88.

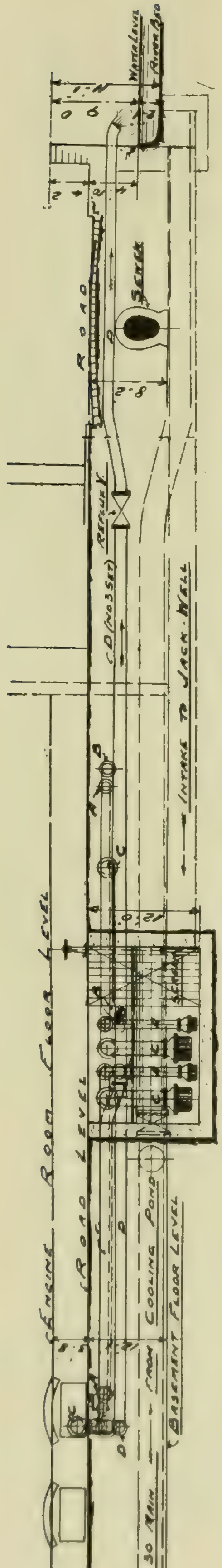
It will be noticed that the jet condensers suck their injection water from a jack well, this well communicating with the river by an underground pipe, fitted with a sluice gate at the well—the air pump sealing water is also drawn from this jack well, and is discharged again in here through pipes B. Fig. 93 shows the jack well pipes, etc., this view being a section on line H.H., Fig. 88. The discharge water from the extraction pumps to the jet condensers to Nos. 3 and 4 sets either goes direct to the river through the pipes marked D on the layout plan, or are led into the race to cooling pond by means of the lift pumps shown, sluice valves being provided to effect this, as indicated.



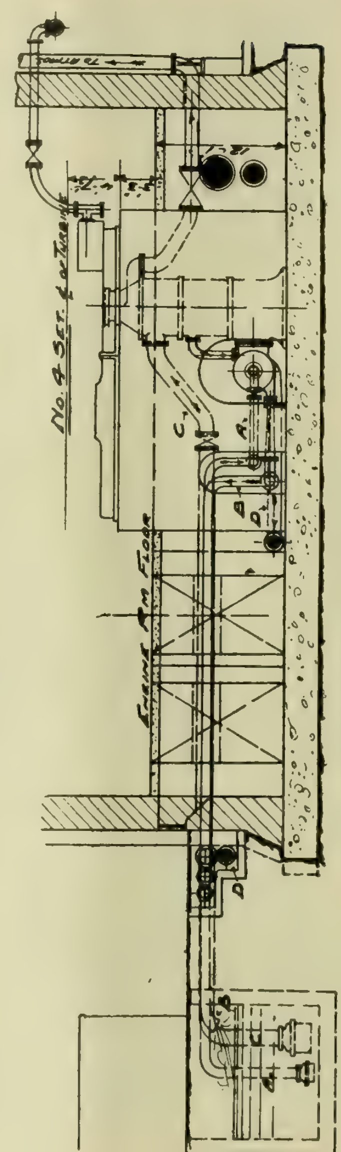
Enginering Lay-out.—Fig. 91.

These jet condensers are of the Westinghouse-Leblanc multi-jet type, and a sectional view of the apparatus is shown at Fig. 94.

As will be seen, the water and steam enter at the top, and are sucked in, due to the vacuum created by the air pump at high velocity through a number of nozzles which have a spiral vane in the centre of each, giving the water a rotary movement, which breaks it up into as large a surface as possible. The cone under these nozzles marked F causes the steam and injection water to be thoroughly mixed, so that condensation takes place rapidly and completely.



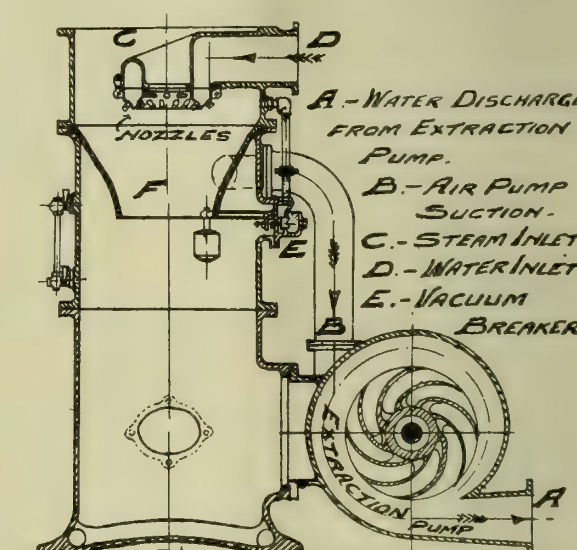
Engineering Lay-out.—Fig. 93.



Engineering Lay-out.—Fig. 92.

When the injection water enters the condenser it has a considerable velocity due to the difference between the atmospheric pressure and the pressure inside the condenser, and in passing through the cone F, this velocity is utilised to give the air and incondensable gases a first compression. The condensed steam and injection water fall to the bottom of the condenser after passing through the cone F, and are then removed by the water extraction pump. The air and incondensable gases separate from the water and are drawn up to the air pump suction pipe at B. It will be seen from the layout views that the impellers of the water extraction and air pumps are mounted on a common shaft, and placed in the same casing, this making the plant exceedingly compact, only requiring the one motor to drive both pumps. The motor is of 150 B.H.P., and a switch pillar and liquid starter are placed on the floor close to same, there just being room to accommodate them.

The motors driving the circulating pumps for the surface sets Nos. 1 and 2 were each 64 B.H.P., and



Engineering Lay-out.—Fig. 94.

those driving the air and extraction pumps each 235 B.H.P. Since the writer last visited this station in connection with the erection of No. 4 set, another 3,000 k.w. jet set has been erected alongside No. 3, on the existing Yates and Thom foundation; this last unit will be noticed in the photograph of the station, Fig. 95, but it is numbered No. 5. As before stated, the sets were renumbered when all were installed, No. 1 being at the river end of station.

The diagrammatic view of the Leblanc rotary air pump to the surface sets Nos. 1 and 2 is shown at Fig. 96.

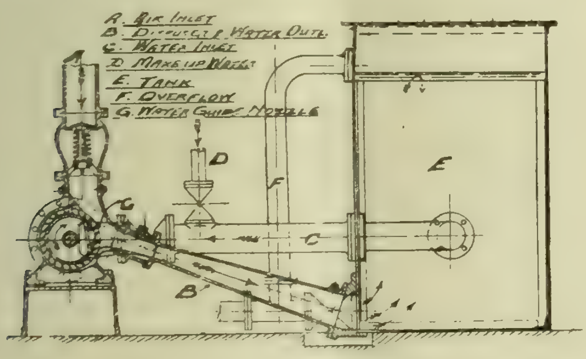
The rotor or impeller of this pump takes the form of a reversed Pelton wheel rotating at a high speed. The water from the sealing tank enters the side of the pump casing, and is cut off in a series of thin sheets, which are hurled at a velocity approaching 130 ft. per second through the collecting cone into the diffuser B. The space between these successive sheets or water pistons contains the air drawn over from the condenser through the suction

pipe A, and this air is compressed up to atmospheric pressure as it is discharged from the pump. This creates a vacuum in the casing, drawing more water into same. Having the sealing water suction under a head, by employing the large sealing water tank shown, the pump remains primed, should the vacuum fall for any reason, picking up again without atten-

Engineering Lay-out.—Fig. 95.

tion. An ejector would be required to effect this if the sealing water tank was below centre of pump.

The sealing water tank is fitted with the necessary overflow and drain connections, and, as will be seen, the suction pipes to air pumps are fitted with strainers. The water is used over and over again, a make-up supply is fitted to replace what water is lost by evaporation; this, if the tank is covered, will



Engineering Lay-out.—Fig. 96.

be practically nil. The extraction pumps work under a small suction head, pockets being provided under condensers as shown, and the pumps deliver the condensed steam to the hot wells in the boiler house. The delivery side of both of these pumps is fitted with a non-return or reflux valve, which is, of course, necessary.

(*To be continued.*)

The imports of tin into the United States totalled 47,000 tons (of 2,240 lb.), in 1919, including 2,625 tons from the Straits Settlements, and 11,596 tons from Bolivia as compared with a total of 67,881 tons in 1918, including 34,243 tons from the Straits, and 9,854 tons from Bolivia.

THE AIR COOLING OF PETROL ENGINES.

By A. H. Gibson, D.Sc.,
University College, Dundee.

The theory of the air cooling of the petrol engine has been investigated in a very comprehensive paper read before this Institution by Mr. F. W. Lanchester in 1915.* It is not intended to deal with this side of the question in the present paper, which records some of the results of experimental work on air cooled engines carried out by the author and his colleagues between the years 1916–1919.

This work was carried out almost entirely on aero engines having cylinder sizes somewhat larger than those adopted in automobile practice. It is, however, hoped that the results may be of some use in the design of air cooled engines suitable for car work, and that the paper may serve to supplement that of Mr. Lanchester.

Laws of Air Cooling.

The cooling surfaces of the modern air cooled cylinder almost invariably take the form of a series of fins, though in some special cases cooling spikes may be used with advantage over certain portions of the cylinder. A large number of tests have been made to determine the rate of heat dissipation from such surfaces, with results which show that for wind speeds between 20 miles per hour and 60 miles per hour, the heat loss is sensibly proportional to the mean temperature-difference between the fin surface and the incoming air, and to the 0·73 power of the wind speed. For a given material the heat dissipation is sensibly independent of the roughness of the surface. Different materials have slightly different dissipation coefficients. A steel surface appears to give somewhat greater heat dissipation than an aluminium or a copper surface, the difference being, however, only about 5 to 10 per cent. The dissipation from cast aluminium fins appears to be improved by a coating of suitable stoving enamel, the difference between the enamelled and plain fins being about 10 per cent.

Over the range of cylinder sizes usual in practice, the dissipation coefficient is sensibly independent of the cylinder diameter.

A large number of tests have been made to determine the heat loss from finned cylinders in a parallel air blast, with results which indicate that, for copper fins, this heat loss is given by—

$$\sigma = (0{\cdot}0247 - 0{\cdot}0054\,(l^{0\cdot8}/p^{0\cdot4}))\,V^{0\cdot73}$$

in Centigrade heat units per square feet per minute, per degree Centigrade of difference between the mean temperature of the fins and that of the incoming air.

Here l is the length of the fins in inches.

p is the pitch in inches, measured from surface to surface of adjacent fins.

V is the wind speed in miles per hour.

This relationship has been deduced from tests on cylinders having diameters ranging from 1·25 in. to 3·75 in., with fin lengths ranging from 0·63 in. (16 mm.) to 1·62 in. (41 mm.), and with pitches ranging from 0·1575 in. (4 mm.) to 0·75 in. (19 mm.). Where the fins are of tapering section, the value of p should be taken at the mean height of the fin.

* See Proc. I.A.E., Vol. X., p. 59.

Shape and Size of Fins.

The fin which gives the maximum heat-loss per unit of weight is one having slightly concave surfaces and a sharp tip. It may be shown, however, that a plain triangular fin is only very slightly less efficient. The best proportions for such a fin depend on the conductivity of the material and on the wind speed. For a speed of 40 miles per hour, Table I. shows the best proportions for such fins of aluminium alloy (conductivity=0·38 C.G.S. units) and steel (conductivity=0·10 C.G.S. units) and also for rectangular copper fins (conductivity=0·90 C.G.S. units).

TABLE I.

Bottom breadth "B" cm.		0·025	0·05	0·1	0·2	0·3	0·4	0·5
Length cm.	Aluminium...	..	..	2·0	2·9	3·5	4·1	4·5
	Steel	..	.	1·1	1·5	1·8	2·1	2·3
	Copper	1·6	2·3	3·3	4·8	..	..	..

If such a fin be truncated until the tip breadth is one-fifth of the bottom breadth, the lengths become 80 per cent of those given above. The heat dissipation is about 0·88 times and the weight 0·96 times as great as for the complete triangular fin.

Since the heat dissipated from a fin of given shape varies directly as the length of the fin, while the weight varies as the square of the length of the fin, other things being equal, cooling fins should be as short as possible, a large number of short thin fins being used in preference to a smaller number of longer and thicker fins. While in practice this is to be borne in mind, many other factors besides that of weight have an important bearing on the best size of fin to be adopted. Thus, in a thin steel cylinder, or in a cylinder of cast iron or cast aluminium alloy, the circumferential ribs add greatly to the strength and resistance to distortion. Comparatively deep and heavy fins have a greater effect in this direction than a larger number of similar but smaller fins giving the same cooling. Again, as the number of fins is increased the pitch is correspondingly diminished. This diminution in pitch reduces the air flow between the fins to an extent which may, with very small pitches, render the fins practically useless for cooling purposes.

In a cylinder of cast iron or of aluminium alloy, foundry difficulties put a definite limit to the minimum pitch of the fins. On the barrel itself a somewhat smaller pitch may be adopted than on the head, or the barrel fins may be turned out of the solid if desired. On account of the complicated form of the cylinder head and ports, however, it is impossible to machine their cooling fins, and the length of many of the cores necessitates the pitch being made fairly large. The minimum practical pitch of fin for such cylinders, having a diameter of from 4 in. to 6 in., is about 8 to 9 mm. or about $\frac{5}{16}$ in. Foundry difficulties also prevent the casting of a fin having a tip less than about 0·5 mm. in thickness, or a root thickness less than about $l/10$, so that an aluminium fin 1 in. long would not have a root thickness less than 0·1 in.

For steel cylinders with fins turned out of the solid, the pitch may, with advantage, be cut down to about ^{1} in. on a cylinder of 3 in. or so in diameter, but there appears to be little to be gained by reducing the pitch beyond this point.

Variation of Cooling with Density of Air.

The cooling intensity of an air blast depends on the weight of air brought into contact with the cooling surfaces in unit time. In the case of an aero engine, the density of the air varies considerably with the height. The weight involved in cooling is proportional to ρV, and the heat dissipated from a finned surface is proportional to $(\rho V)^{0·73}$. In the case of an automobile engine the variation in density may, in general, be neglected except for units designed for operation at high altitudes.

Heat to Cylinder Walls and Piston.

The amount of heat transmitted from the working fluid to the walls and piston of an internal-combustion engine depends upon a number of factors, including:—

(*a*) the design of the cylinder,
(*b*) the strength of the working mixture,
(*c*) the spark advance,
(*d*) the compression ratio,
(*e*) the fuel used,
(*f*) the speed of rotation,
(*g*) the size of the cylinder.

The bearing of these various factors will be considered at a later stage.

Since the heat transmission from the fluid to the walls during its most important stage, *i.e.* during and directly after explosion, is largely due to radiation, and is therefore probably approximately proportional to

$$(T_g^4 - T_w^4) \text{ where } T_g \text{ and } T_w$$

are the absolute temperatures of the gas and the walls, any such difference of wall temperature as is likely to exist in practice between an air cooled engine and a water cooled engine can have little effect on the rate of heat transmission. As a matter of fact, such measurements as have been made show that the differences in wall temperature, piston temperature, and exhaust valve temperature, between a well-designed air-cooled cylinder and the corresponding water cooled cylinder are small, and that unless the water cooling system is well arranged, the air cooled cylinder may be, and often is, actually the cooler of the two.

In view of this, since it is much easier to obtain a measurement of the heat flow through the cylinder walls of a water cooled engine than through those of an air cooled engine, where such heat-loss can only be determined from the heat balance sheet by differences, such determinations have usually been made on water cooled engines. It is true that, since the water jacket surrounds the exhaust port or a short length of the exhaust pipe, the heat measured in this way includes a proportion of heat which should, correctly, be included among the heat of the exhaust, but as in both cases this heat has ultimately to be dissipated, in the one case by the radiator and in the other case by the cooling fins, this forms the essential heat flow so far as cooling problems are concerned.

(To be continued.)

HYDRAULIC POWER IN MADAGASCAR.

Water power is now attracting attention in this distant part of the world, and decrees, recently issued by the Governor-General, have now provided for the utilisation of the power afforded by the rivers Aukitakazo, Ampandrano, and Sahapazana, with a view to the obtaining of cheap motive force.

FOREIGN TRADE POSSIBILITIES.

The Department of Overseas Trade, 4, Queen Anne's Gate Buildings, Old Queen Street, London, S.W.1, have supplied us with the following important information issued by the Intelligence Branch of that Department.

HYDRAULIC POWER IN THE ROUMANIAN RIVERS.

According to an estimate of the hydraulic reserves of Roumania, published in the Bulletin of the State Railways, there is a force of 841,093 H.P. which could be transformed into energy. This conclusion is based upon the flow in the rivers at the driest season of the year.

In order to arrive at the actual horse power available, it would appear to be the practice to increase this by 150 per cent, a course which brings the total available horse power up to 2,250,000. This total would be reached by the erection of the proper works, etc.

According to the Bulletin mentioned, in the year 1913 only a force of 41,000 H.P. was exploited.

Details for the various rivers are as under :—

	Available power per second.
Northern Theiss with tributaries	140,000
Somesh with tributaries	78,960
Crishel with tributaries	52,990
Murash (Maros)	331,890
Temesh	77,320
Bega and Lasa	4,180
Cerna	21,934
Bela	3,585
Globu	655
Jiul, in Roumania (old)	11,818
Jiul, in Transylvania	10,094
Olt	104,970
Oituz	1,697
Total	841,093

TENDERS FOR CAST-IRON SOCKET PIPES.

His Majesty's Vice-Consul at Trondhjem, Norway, has telegraphed to this Department to the effect that the Trondhjem Waterworks are calling for tenders for 6,400 running metres 15 in. and 1,200 running metres 9 in. cast-iron socket pipes, representing in all about 900 tons, also for the necessary fittings, including bends, socket ends, spigot pipes, connection sockets, T pipes, and bland (? blank) flanges.

It is stated that alternative tenders are required for 12 in. pipes which may be taken instead of the 15 in. size mentioned above, and that all must be vertical cast with "Rissel" in socket and band on the spigot pipes, guaranteed to 20 atmospheres pressure.

All the material is required as early as possible, and delivery has to be made free of breakage, free on land in Trondhjem.

Particulars of weights, thickness, etc., should accompany the tenders, which must be presented to Stadsingenioer Thesen Trondhjems, Stadsungenioerkonter, Trondhjem, before the 20th of February.

Should you find it impossible to name figures inclusive of landing charges, prices delivered f.o.b., Trondhjem may be quoted, but to enable buyers to make the comparison it will be necessary for firms tendering on this basis to call attention to the fact that their offers are only for this delivery.

It is not clear if by quoting prices landed in Trondhjem contractors will render themselves liable for import duties, which on cast-iron pipes and fittings in Norway are 50 ore per 100 kilos, and when lodging tenders based on such delivery firms should take the precaution to state whether their offer is inclusive of duties or net.

I shall be glad if you will kindly inform me of any action you may find it possible to take in regard to the foregoing.

This information has been the subject of a notice in the *Board of Trade Journal* of the 5th February.

P.S.—Kroner 19·55 = 19·60 = £1 present value. 100 ore = kroner.

STEAM CRANES FOR DUNKIRK.

A despatch has been received in the Department of Overseas Trade from His Majesty's Consulate at Dunkirk, France, stating that the local Chamber of Commerce at their meeting of the 23rd January expressed themselves in favour of the installation of two steam cranes on the north quay of the Bassin de la Marine of that port. The company using this quay is the "Societe du Port de Givet," shipowners, of 7 Rue du Bastion, Dunkirk, and the cranes are to be installed by them.

There are no details given as to the type or capacity of the cranes likely to be adopted, and in this connection it is suggested that, if interested in this possible trade opening, you should address enquires to the company of shipowners above mentioned.

BRIDGE DESIGNING COMPETITION IN DENMARK.

A despatch has been received by the Department of Overseas Trade from His Majesty's Commercial Secretary at Copenhagen (Mr. Richard Turner) to the effect that a competition has been instituted by the municipal authorities of Aalborg in designs for a bridge which it is proposed to construct across the Limfjord between Aalbory and Norresundby.

A notice on the subject has already appeared in the press, but some photographs, together with maps, drawings, and conditions of the competition, which are in both Danish and English, have been received and may be useful as additional information. They may be inspected at the Enquiry Room of this Department.

This information is sent you in view of the possibility of a contract arising from the competition, though it is understood that the actual building of the bridge may be postponed for some time owing to the difficulties of the present economic situation in Denmark.

Should you be interested in the matter, however, it is possible that you might be able to make some financial arrangement with the municipal authoities by which the scheme may be put into operation at once. The Commercial Secretary, however, places emphasis on the fact that the Danish scale of wages is very high, and this would have to be carefully borne in mind in any arangements which it might be proposed to make.

DIESEL ENGINES.

His Majesty's Commercial Commissioner in Berlin has forwarded to the Department of Overseas Trade the following statement, showing the comparison of export and home trade prices for "Diesel" engines :—

		Dols.	Marks.
50 H.P. one-cylinder Diesel engine without accessories		5,800	180,000
Pipes, oil vessels, and all other necessary accessories, including packing		1,500	22,000
Special charges for America :—	Dols.		
Freight	500		
Assembling	400		
Duty	800		
	1,700	1,700	
		9,000	
100 H.P. two-cylinder Diesel engine...		8,500	280,000
Accessories		2,000	32,000

TENDERS INVITED FOR ELECTRICAL PLANT

With reference to the announcement issued on the 16th February respecting a call for tenders for the supply of electrical plant to the Oudtshoorn Municipality, His Majesty's Trade Commissioner at Cape Town informs the Department of Overseas Trade that the time for lodging tenders has been extended from 24th March to 24th April.

Tenders should be sealed and endorsed on envelope "Tenders for Electrical Plant" and addressed direct to the Town Clerk, Town Offices, Oudtshoorn. A copy of the specifications and full particulars may be obtained from the Municipal Electrical Engineer, Box 132, Oudtshoorn, C.P.

A copy of the specification and blue prints may be consulted by British firms interested at the Enquiry Room, Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, S.W.1.

BRITISH PUBLICITY AND ADVERTISING IN SOUTH AFRICA.

The question of advertising as a policy, its efficacy and its method, is a very large one which has in recent years formed the subject of a number of serious literary works and treatises.

Most, if not all, of these deal with the question from the point of view of the advertising contractor and publicity expert, and they do not therefore indcate the limitations of advertising the points where publicity in its ordinary sense fails to help business and becomes merely extravagant expenditure.

Furthermore, this class of literature seems to regard too much the consumers of goods, whom advertising is intended to influence, as of one type; to treat the whole world as susceptible in the same degree and as likely to be impressed in the same way by the same form of advertisement.

The science of publicity has been worked up mainly in America, and the attitude of mind indicated above pervades all American sales methods and salesmanship.

The whole theory of advertising is based primarily on a study of temperament and human nature, but it breaks down in practice owing to failure to carry this study right through.

Humanity is regarded in the mass as having a few prominent characteristics and weaknesses in common which can be prescribed for and treated in the mass.

Knowledge of the Market and Local Conditions Necessary.—Many advertisers ignore the fact that local prejudice, taste, and sentiment, religious beliefs and social customs have got to be very carefully studied by those who wish to advertise, and used as the basis for decision as to both the mode and the form of advertisement. A salesman or canvasser who finds bluster, exaggeration, decrying the goods of competitors and similar methods successful in one market may find himself refused a hearing in another. And similarly there are markets and buyers who attach no weight to the opinion of an agent because he is quiet, scrupulously fair to competing goods and strictly accurate as to the merits of his own.

In the case of advertising the difference is even more pronounced. The number of possible methods of publicity and alternative combinations of these are sufficiently numerous. Appeal through the press may be made in the daily, weekly, specialised, and technical papers; it may take the form of cleverly-written letterpress, design, or fine art colour printing; or, again, it may be confined to home journals and magazines which circulate overseas; costly enamel signs on railway platforms, placards on trams, electric light signs, advertisements on theatre and bioscope screens, calendars, and advertising novelties distributed free, informative films at the bioscope, shop window display, exhibitions, demonstrations, whether organised in showrooms or conducted by personal canvass; all these besides many others are forms of publicity work which have to be studied in relation to the nature of the goods and the taste of the market as a whole or the particular class of customer whom it is desired to impress.

And similarly with the customer, while the man of science or technical knowledge requires an appeal to a trained intelligence and needs convincing by demonstration or solid argument, others are caught by appeals to the eye, to credulity, to vanity or to economy. Some can appreciate beautiful design and colour, while to others what is crude and garish present attractions. Real humour in a poster or calendar real utility in some little advertising novelty distributed free may equally produce a little grateful sentiment in favour of one make or brand as against competitors.

It is equally necessary to know what to avoid. Advertisements which, through ignorant drafting, unpopular or unlucky colouring, give offence are more damaging than those which merely misfire either through being dull and unconvincing or through not being presented to the right section of the public.

It is a fact that enormous sums of money are simply wasted through adopting faulty methods and wrong media. The point is that publicity work is highly scientific and needs the life study of a capable, resourceful, imaginative and sensitive man. And the corollary to this is that an adviser on advertising must of necessity have a very intimate knowledge of the country in which the advertising is to be done. He must have a knowledge of the people and their tastes, and he must know and have access to all media. The fact that an advertising agent is in close touch with the press or has special concessions on trams or railways or influence with the bioscope theatres is not of itself a recommendation. A good advertising agent must have access to all, and must know the exact value of each medium for getting at the particular class of buyer in question. Press advertising is useless if the buying class is illiterate or does not read the language of the organs utilised. If a question arises as to whether it would pay to attempt to convince native consumers through the bioscope, it is necessary to ascertain how far natives attend such places of entertainment. The question is often raised as to the advisabilty in South Africa of advertising in Dutch. In order to answer this question study is required as to how far the class of goods in question are saleable to that section of the Dutch speaking population who either do not understand any other language or are likely to appreciate and be influenced in buying by seeing advertisements reproduced in "the Taal' or Africans, as the locally spoken Dutch is called.

The extent to which concessions or adaptation to caste rule and religous prejudice and custom are necessary may not be as great in South Africa as, for instance, in India or China. On the other hand, the mere reproduction in South Africa of letterpress or posters designed for a home market without any local knowledge of their suitabilty is usually a waste of money. South Africa is a very large country, and though the population is not large, it is highly complex and necessitates as close and prolonged study before maturing a selling or an advertising campaign as any other country. A very responsible expert advertising agent in the union once gave his opinion to His Majesty's Senior Trade Commissioner that even a resident in the country could very rarely have had the opportunity for studying the peculiarities of taste—as modifying the style of advertising required—of all districts and classes of population. If that is the case, it is impossible for anyone not resident here or intimately acquainted with the country to give adequate advice on advertising policy or method and direct outlay on publicity unless he has expert agents on the spot working in co-operation with him.

Among the many and various questions on which His Majesty's Senior Trade Commissioner is consulted both from England and in South Africa is advertising policy. When it appears clear that this course is not being adopted merely in order to avoid paying fees to an expert whose particular business this is, Mr. Wickham is very ready to give such advice as he can on general lines and to warn of particular dangers and pitfalls. It is a matter of no great difficulty to anyone studying local trade to have an adequate idea of the class of public reached by particular advertising media or to indicate the particular class of buyer who should be aimed at in advertising.

The point which is brought out in the above notes is that advertising is not a matter for simple advice; it is not one which can be dealt with in a short memorandum in such a way that a manufacturer can turn to this and find out whether he should advertise in the South African market, how much he should spend, and what media he should use.

The advertiser should consider himself fortunate in that it is the only branch of the large subject of distribution which has its literature and its experts. The manufacturer can discuss with an expert what he can afford to spend and leave the whole working out of a campaign to him.

The Manufacturer Must Pay for the Publicity, not the Merchant.—Mr. Wickham lays particular stress on two points; the first is that if goods need advertising in order to obtain sales then the manufacturer must see to it that they are advertised. It is useless to hark back to the out-of-date theory that this is the business of merchants or agents. Many merchants do not care whose goods they sell. They will always give preference to those which sell most readily, and these are generally those which are most freely advertised. But they will seldom if ever undertake the cost or trouble involved in publicity work. There is really no possible reason why they should be expected to. It is the manufacturer who profits most by the sale of his own goods instead of some alternative make; it is he who knows their intrinsic value and their selling points; and in any case if the manufacturer will only realise that advertising must be done by someone and that it is he who loses most if it is not done, he will then probably realise that it is better to undertake it himself, supervise it, and see that it is done properly than to leave it to chance or expect someone else to do it for no better reason than that he has never done it before. In Mr Wickham's opinion the cost of advertising, whoever pays it in the first instance, is in the end partly borne by the consumer. If distribution is properly organised and goods are properly put before the consumer, it is the ultimate cost to the consumer and not the f.o.b. or the ex-factory cost on which the demand and the turnover depend. Manufacturers still often talk as though by refusing to pay for advertisements themselves, and by quoting packing as an extra they were really effecting a reduction in cost and producing an attractive economy, even though their goods have to be packed before they can be exported and advertised before they can find a market.

Advertising Campaigns Based on Potential Sales.—The second point is that the outlay on advertising should never be based on existing sales, but on potential sales. It is a disastrous error exceedingly common among British firms to refuse to throw bread upon the waters. It is merely a matter of bad bookkeeping. Advertising to produce future sales is in the nature of capital expenditure. To keep the cost of advertising strictly within the bounds of what the existing turnover will bear, to expect to pay for it out of the profits on present sales, is to miss the whole point and aim of advertising. Estimate the value of profits of the turnover which it is hoped may be secured in that market, and then calculate on that basis what outlay on advertising can be afforded. It will not infrequently involve spending more for a year or two on advertising than the gross value of turnover in that market.

Advertise the Merits of the Goods.—A subsidiary piece of advice in the South African market is to stress genuine selling points such as quality, durabilty, and suitability for that market, and not to expect to sell goods merely by harping on the fact that they are British made.

There has been in the past and there are now on the South African market British goods which are not suitable in design for that market and which are neither durable nor good value. The South African market cannot be expected any more than others to buy unsuitable quality and poor value merely on sentiment. If there are genuine selling points to advertise, advertise them.

MODERN MACHINE SHOP PRACTICE AND THE LIMIT GAUGE SYSTEM.

By M. Coronel.

(*Continued from page 203.*)

Gauges, setting prices, measuring rods and micrometers are all, however, liable to change their accuracy due to wear and tear and differences in temperature, and to check periodically the accuracy of such the measuring machine is used, which gives readings to $\frac{1}{10000}$ of an inch. Every modern inspec-

Fig. 8.—Point Gauge. (Hard Wood Handle.)

Fig. 9.—Flat Point Gauge. (Hard Wood Handle.)

tion department or tool room should have such a machine for checking purposes, and to duplicate existing standards.

Most measuring machines are constructed on the principle of the external micrometer gauge, and consist of a small lathe bed with a head and tail stock, Fig. 22. The head stock consists of a micrometer screw with a large divided wheel at its end, and a

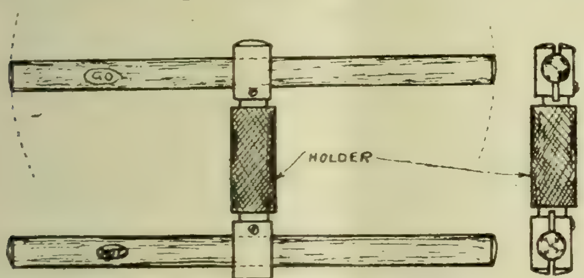


Fig. 10.—Spherical End Internal Limit Rods.

vernier attached to read sub-divisions, and as very often a spirit-level, microscope and rests for supporting measuring rods and other articles to be measured. These machines should be placed in such a position as to be free as far as possible from vibration and the effect of frequent change of temperature, and it is essential that they should not be exposed to the direct influence of the sun's rays. They are most

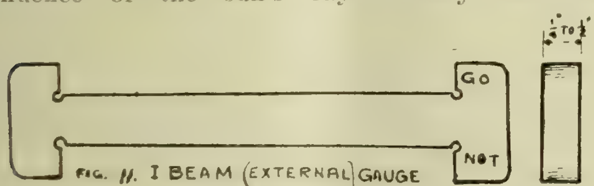


Fig. 11.—I Beam (External) Gauge.

conveniently placed in a room by themselves where all fine measurements should be taken. The bed of the measuring machine is provided with a long divided rule, and the tailstock is set by moving the same along the bed, and setting same by taking the reading through the microscope on the divided rule, the line wanted falling between two hairlines stretched across the optic of the microscope.

They are made to measure lengths from 0 ft. to 6 ft. For the purpose of showing how much touch the measuring rod has between the anvils of the head and tailstock, the latter is made floating in the bearings of same, and its movement is transmitted by a bell-crank lever to a tilting graduated

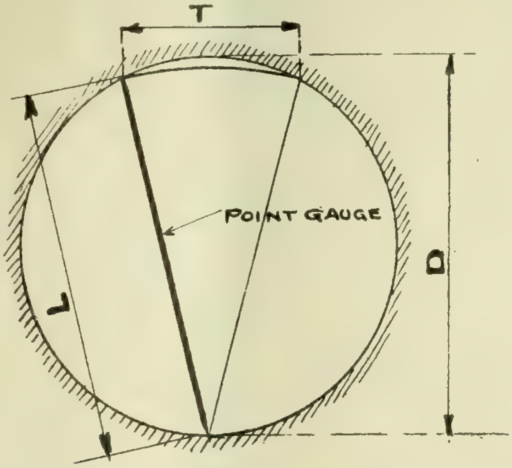


Fig. 12.

spirit-level fixed to the tailstock end, and the movement of the bubble is by special construction made to magnify the anvil movement by 4,000. One gets therefore a magnified visbile sign of the amount the

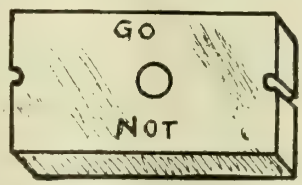


Fig. 13.—Setting Piece for Adjustable Caliper (External) Gauges

measuring rod is too short or too long, and also gives the amount of pressure exerted between the two anvils and the article to be measured, without leaving it to the inspector to feel this by touch.

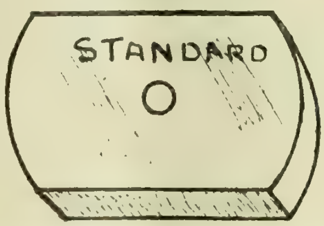


Fig. 14.—Setting Piece for Adjustable Caliper (External) Gauges and Standard Reference Bar.

The *Tool Room*.—This department is of the greatest importance in a modern works, and much more than its name would imply. It is the feeder for the machine shop, and the place where tools, jigs, gauges

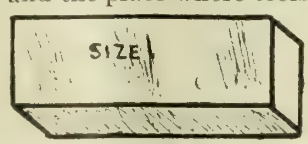


Fig. 15.—End Measuring Block for Setting up Micrometers and Testing Parallel Surfaces.

and other labour-saving appliances are kept, suggested and made in conjunction with the drawing office for new work to be done.

The tool room is an integral part of the limit system, and the growth of this system for interchangeability of parts is to a large extent subject to the degree of efficiency of the tools turned out by it. It does away with the "try and guess" system, or the lack of system of old, and avoids misplacement and losses of tools, jigs and fixtures in the shops. The tool room should issue checks to each workman for the requisition of tools, gauges, etc., which they

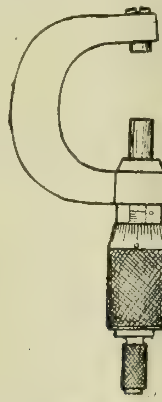


Fig. 16.—Micrometer Caliper.

exchange for a tool when they require same, the check being placed in the place the tool usually occupies. All tools and gauges should have their apointed place in shelves, pigeon holes, and racks; each rack, etc., should contain if possible one kind of tool or gauge only, and various classes of shelves or bins should be kept for various classes of gauges and tools, see Figs. 24 and 25.

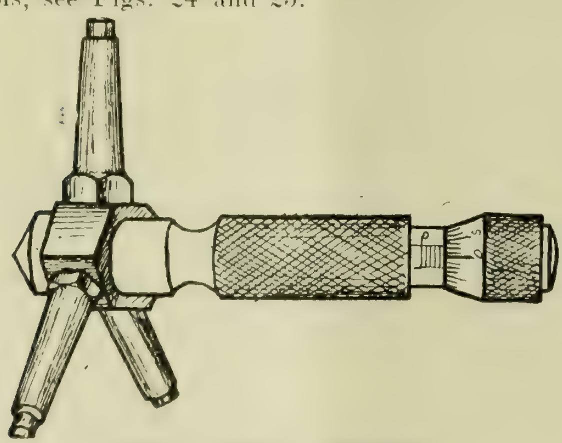


Fig 17.—Internal Micrometer.

The tool room is further, with regard to its machine tools, like a miniature machine shop, but its equipment mainly consists of universal machines and general lathes, and a few special tool grinding machines, hacksaws, besides a large assortment of measuring instruments, a measuring machine, a small marking out table, and a sensitive drill, etc.

The work done there is mostly of a small but accurate nature, and it therefore should be well lighted in the daytime and also after dark.

Belts and line shafts are therefore to be avoided and individual electrical drive is much to be preferred.

Often, several machines stand idle for a considerable time due to no work of that class being in progress, and a lot of idle running would be the consequence.

(To be continued.)

FORTHCOMING FAIRS.

UNITED KINGDOM.

London Fair and Market—
March 16–26th, at Royal Agricultural Hall. International Trade Exhibitions Ltd., Broad Street House, E.C.2.

Building Trades Exhibition—
April 1st–23rd, at Olympia.

Drapery Exhibition—
April 12th–23rd, at Royal Agricultural Hall, International Trade Exhibitions Ltd., 31, Queen Victoria Street, E.C.2.

Business Exhibition—
May 4th–15th, Royal Agricultural Hall. Address: 36–38, Whitefriars Street, E.C.4.

Photographic Fair—
April 16th–24th, at Horticultural Hall, Westminster. Organising Secretary, Sicilian House, Southampton Row, W.C.1.

Canadian Products Exhibition—
June 3rd–17th, at Agricultural Hall, Islington. Address to 43, Essex Street, Strand, W.C.2.

Aero Exhibition—
July 1st–24th, at Olympia. Address to 83, Pall Mall, S.W.1.

Empire Timber Exhibition—
July 5th–17, at Holland Park Skating Rink. Organised by Board of Trade.

Clothing, &c., Exhibition—
July 5th–16th, at Royal Agricultural Hall, International Trade Exhibitions Ltd., Broad Street House, Old Broad Street, E.C.2.

Health Exhibition—
July 19th–August 5th, at Bingley Hall, Birmingham. Organised by Royal Sanitary Institute, 90, Buckingham Palace Road, S.W.1. Entries by June 26th.

Bakers', Confectioners', and Allied Traders' Exhibition—
September 4th–10th, at Royal Agricultural Hall. Trades, Markets, and Exhibitions Ltd., 31, Queen Victoria Street, E.C.4.

The Machine Tool and Engineering Exhibition—
September 4th–25th, at Olympia. The Machine Tool Trade Association, Incorporated. Applications by July 31st, to Secretary, Queen Anne's Chambers, Tothill Street, Westminster, S.W.1.

Grocers', Provision Dealers' and Allied Traders' Exhibition—
September 18th–24th, at Royal Agricultural Hall. Trades, Markets, and Exhibitions Ltd., 31, Queen Victoria Street, E.C.4.

Motor Exhibition—
October 7th–27th, at Olympia. Motor Manufacturers and Traders Ltd.

OVERSEAS.

Lucerne Third International Fur Fair—
March 23rd–27th.

Paris Industrial Art Salon—
March to July. Provisional Office: 1, Rue de Heider, Paris (9e).

Tokio Overseas Expansion Exhibition—
March 15th–June 7th.

Milan Fair—
Allied and Neutral, Industrial and Agricultural Fair. April 12th. Sixty stands reserved for British Exhibitors. Agents for British Empire, British Italian Corporation Ltd., 12, Nicholas Lane, E.C.4.

Brussels Commercial Fair—
April 4th–21st. Open to allied and neutral countries. Applications by February 28th, to Comité Directeur de la Foire Commerciale, Grand Place, Brussels. (See *Board of Trade Journal*, December 11th.)

Basle Sample Fair—
April 15th–29th, at Basle. For Swiss goods only.

Norwegian Industries Fair—
Christiania, Spring.

Breslau Exhibition—
April 26th May 1st. Apply to Breslauer Messe Gesselschaft, Breslau, Ohlauer Strasse 87.

Bandoeng Fair—
May, 1920. (See *Board of Trade Journal*, December 18th.)

Barcelona International Fair—
May 15th–30th. Applications to La Direccion General de la Feria de Barcelona, Fernando 30, Barcelona, by January 15th. Also an International Business Organisation Exhibition (office furniture, appliances, etc.), at Palaccio de Bellas Artes, Barcelona, in October.

Venice Art Exhibition—
Twelfth Exhibition of International Art, April 15th–October 31st, by municipality at the Exhibition Palace. Exhibits to be received by March 10th. Address : Ufficio di Segretaria dell Espozione (Municipio), Venice.

Lille International Exhibition—
May–October. Organised by Corporation.

Padua Sample Fair—
June, 1920. Applications to 1a, Camera di Commercio di Padova.

Bordeaux Trade Fair—
Fourth Annual Fair, June 5th–20th.

Sundsvall Fair—
June 21st–27th.

Helsingfors Trade Fair—
June 27th–July 6th. Apply to "Forhindets för Inhemskt Arbite." (See *Board of Trade Journal*, January 29th.)

Ostersund Exhibition—
July 2nd. (See *Board of Trade Journal*, February 5th.)

Geneva. Swiss Watch and Jewellery Fair—
July 11th–25th, at Geneva. A National Fair.

Lausanne. Alimentary and Agriculture—
September 11th–26th, 1920.

Antwerp Colonial Exhibition—
To be run in conjunction with the Olympic Games.

Copenhagen Automobile Exhibition—
Early this year. Organised by the Association of Automobile Merchants of Denmark. (See *Board of Trade Journal*, January 8th.)

Spring Fairs—
Will be held in Lausanne and Lucerne, Switzerland; Valencia, Spain; Frederica, Denmark, and Metz.

Summer Fairs—
Are anticipated at Mälmo (Sweden), Antwerp, Quebec, and Libau.

The Heat Treatment of Metals.—In the course of a lecture delivered on March 10th before the Royal Society of Arts on "Gas in Relation to Increased Output for National Economy," Mr. H. M. Thornton, the well-known authority, called attention to the present urgent need for machinery of all kinds and types, since this was the only way in which we could compensate to any considerable degree for the loss of labour in the war, the reduction of hours per week and the national inclination of workmen to desire less strenuous occupation. The heat-treatment of metals was of primary importance in assisting the output of machines, tools, and labour-saving and cost-economising devices. Heat was a universal necessity in manufacture, and coal was the most adaptable and efficient means of providing that heat, enabling, as it did, the fullest possible value to be obtained from the coal used. It eliminated waste and cheapened production.

THE METALLURGICAL INDUSTRY IN BRAZIL.

According to recent estimates the beds of iron ore in the province of Minas Geraes contain $3\frac{1}{2}$ milliard tons of ore of excellent quality. The number of the beds is from 50 to 60; the percentage of iron in the ore varies from 60 to 70 per cent. It is calculated that for a period of 25 years Brazil will still have to import about 55 million tons of iron and steel manufactured goods. If it be taken into consideration that the imports of iron and steel necessary to increase the railway service to 200,000 kilometres (now covering only 20,000 kilometres) will amount alone to 16,000,000 tons, then it will be seen that the total of 55 million tons is by no means exaggerated. Brazil also intends to triple her merchant marine, and that will also necessitate a lot of iron and steel. Brazil could also export a lot of metallurgical products to the South American Republics, but she is hampered in this by the lack of coal. However, it is hoped to remedy this by employing electricity in the foundries, and, furthermore, plans are now afoot for the utilisation of the various sources of hydraulic power available in the country.

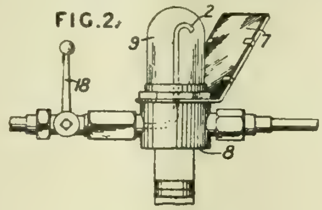
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

LUBRICATORS.

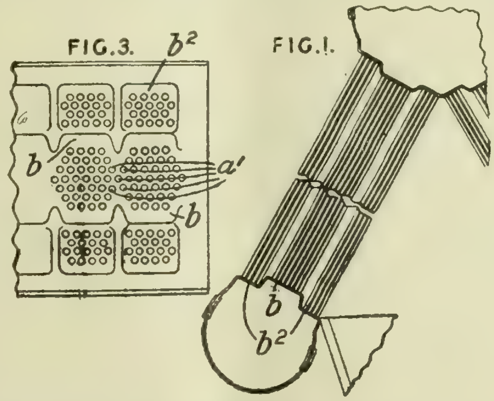
126,203.—Y. H. COX (Representative of R. J. Isaacson), Bendemere, Southwick, Sussex.—June 27th, 1918.—A sight-feed device consisting of a glass dome 9 and a drip pipe 2, placed in the lubricant circuit of a motor-cycle or vehicle, etc., is furnished with an



inclined mirror 7 so arranged that the drip and the surface of oil in a cup 8 can be readily seen. The device is placed in a substantially closed circuit including an oil reservoir, an engine casing, a stock-cock 18, and a small rotary pump furnished with a by-pass and relief valve.

STEAM GENERATORS.

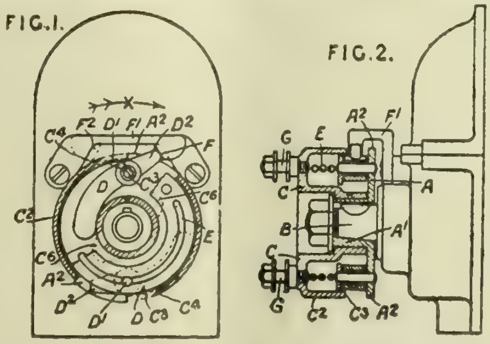
126,159.—V. SMITH, 53, Bath Road, Wolverhampton, Staffordshire.—May 13th, 1918.—Relates to a boiler of the Yarrow type having pressed-out pockets b, b2 in the drums forming flat surfaces to receive the tubes, each of the surfaces



being of such length and width as to receive two or more tubes longitudinally and transversely of the drums. Additional tubes a1 are fitted in the spaces between the groups of tubes connected to the flat surfaces b in the middle of the drums. These flat surfaces may be continuous along the length of a drum. The tubes are arranged in staggered relation to one another.

DRIVING MAGNETOS.

126,426.—M.-L. MAGNETO SYNDICATE, Victoria Works, and C. E. HULSE, 46, St. Nicholas Street, both in Coventry.—April 12th, 1918.—A magneto is driven through a form of coupling in which a driven disc A keyed on the magneto shaft B is arrested during



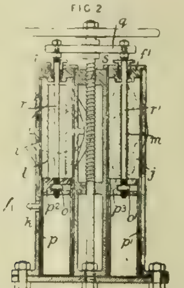
part of each revolution and then released and rotated by a helical spring E to produce an ignition spark at low speeds. The disc A is provided with a boss A1 which forms a bearing for a driving member C, the members A, C being coupled together by the spring E. Two weighted levers D are pivoted on the disc A and can turn upon their pivots D1 so that the short arm D2 protrudes from the coupling; gaps C3 are provided in the flanges

C2 for the purpose. Projections A2 on the disc A extend into the gaps C3 to allow a certain amount of angular movement of the members A, C. The member C is coupled to the engine either by means of the pins G, or by a chain-wheel mounted upon the flange C2. As the member C is rotated slowly in the direction of the arrow X, the short arm D2 of one of the levers engages a fixed abutment F, arresting the disc A; continued rotation of the member C stresses the spring E until the inclined edge C4 of the gap C3 makes contact with the arm D2 and tilts the latter out of engagement with the abutment F, thereby releasing the spring and accelerating the magneto armature. When a certain speed of rotation is exceeded, the longer arms of the levers D are thrown outwardly by centrifugal force and move the arms D2 from contact with the abutment. For giving one spark only per revolution, a single lever is employed and is balanced by a counterweight. As an alternative to the inclined edges C4, cam swells C6 on the boss of the member C may engage the long arms of the levers D. The stop F is carried by a bridge F1 secured to the magneto. The support may be constructed initially with two abutments F, F2, one for right-handed and the other for left-handed rotation of the magneto, the one not required being subsequently removed. For the direction of rotation opposed to the arrow X, the abutment F2 would be used and the levers D would be placed on their pivot pins so as to point to this abutment, the position of the cam edge C4 being correspondingly altered.

VALVES.

126,421.—A. C. IONIDES, 34, Porchester Terrace, London.—April 8th, 1918.—A valve device, particularly applicable for controlling

FIG 2



the supplies of air and gas to a combustion or heating device, has long, narrow ports simultaneously altered in length by manipulating a single actuating-handle, one or both of the ports being independently adjustable in width. In the form shown, the two ports *l*, *m* are formed in hollow cylindrical liners *i*, *j*, the one *i* being rotatably adjustable by means of a lever *k* passing out through a slot in the casing so that the slot *l* may coincide more or less with a similar slot in the fixed casing. If both liners are adjustable, the arms may be connected together to ensure simultaneous angular adjustment. The slots are altered in length by piston valves comprising tubular members *p*, *p1*, closed at the top by discs *p2*, *p3* slotted to receive nuts *o*, *o1* on the spindles *r*, *r1*. The spindles pass out through stuffing-boxes *f*, *f1* and are coupled to a cross-head *q* adapted to be reciprocated by a screw *s* rotatably mounted in the cross-head and engaged by a nut formed in a bar connecting the two casings. The lower part of the screwed spindle is unthreaded and provided with graduations to act as an opening indicator.

VALVES.

126,481.—W. L. GARRETT, 113, Cromwell Road, Bristol.—May 13th, 1918.—A series of independently-actuated cocks are interlocked by means of a transversely-disposed locking-bar provided with gates for a series of plungers so arranged that endlong movement of one plunger imparts endlong movement to the locking-bar to prevent movement of the other plungers. The figures show the invention applied to a valve device having an inlet B4 and three

FIG. 3.

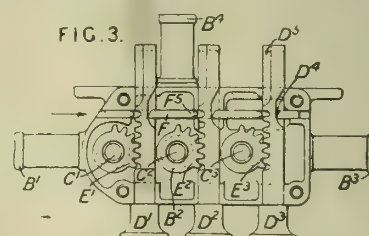
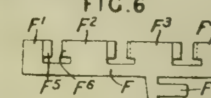


FIG. 6



outlets B1, B2, B3 controlled by three cocks C1, C2, C3 provided with toothed sectors E1, E2, E3 engaging racks on pull-actuated plungers D1, D2, D3. The locking-bar F is pressed towards the left by a spring engaging a projection F7 and has faces F6 formed on lugs F2, F3. F4 adapted to be engaged by cam surfaces D4 on the plungers. The bar also has projections F5 formed on the lugs F1, F2, F3 adapted to engage locking-recesses in the plungers when one or other of the plungers is actuated, the projection corresponding to the actuated plunger then moving into a recess D5.

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— THE —

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VOL. VIII.] APRIL 8TH, 1920. [No. 104

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CONTENTS.

EDITORIAL.

AIDING THE TECHNICAL STUDENTS.

SURELY one of the most prominent features of any reconstruction scheme to-day should be the provision of a steady supply of well-trained, practical young men, who will be able to take a prominent part in carrying out engineering development. In the past there has been a very unfortunate apathy apparent amongst engineers generally in regard to the student trained in a College of Technology or in the engineering department of one of our Universities. Some more enlightened firms have recognised the value of the highly-trained man—at the same time not being blind to his shortcomings in regard to practical application or production on a commercial basis. They have persisted with these young men, who undoubtedly have become valuable members of the firm.

But to-day there is an insistent demand for increased production. Many firms cannot be handicapped by having such men in their works, and in many quarters we see little hope of the fulfilment of the desire expressed by Professor C. B. Dewhurst that students should be taken into works during the long summer vacation.

Experience has proved that many young men, who pass from the college or university to the works, are absolutely devoid of any sense of commercial production. There is, undoubtedly, a growing feeling that in many directions the tendency is towards the academic rather than the practical. Co-operation and co-ordination—two glorious words—are preached, and certainly could be utilised to secure better results than in the past.

Undoubtedly there should be a keener desire to assist the colleges and universities, and if the product is not up to standard, then emphatic protest should be made and constructive criticism offered from those who, after all, will ultimately reap the benefit. Continuous education up to 27 years of age, without a proper correlation of practical and theoretical training, will not produce a manager, or even a foreman. The most receptive years are those which lie between 18 and 24. It is in those years that the mind should be trained to recognise values, besides acquiring the theoretical and practical qualifications necessary to any particular manufacture.

When we get a proper co-ordinate system of training—and the need is imperative—then shall we provide that type or class of man who will develop our reconstruction schemes and effect the descent from the abnormal, which is so urgently necessary.

REDUCING INITIAL COST OF STRADDLE MILLING CUTTERS. Two side milling cutters were required for a certain straddle milling operation which it was desired to carry on almost continuously. The cutters were of large size and the the purchase of two extra cutters, so that one set could be ground while the other was in use, was an expense out of proportion to the returns for the work, yet the time lost in sharpening after both sides of each cutter became dull was an item too large to be overlooked. The scheme adopted was to buy one extra cutter. The two cutters on the machine could then be kept in operation while the third was being ground. When the opposing edges of the running pair became dull, instead of reversing these two, as is customary, one cutter was removed, and the other reversed and set up with the sharp cutter. Following this practice, there was never any delay in changing cutters more than that which occurs in changing to another set of cutters or at a change of position. The more frequent grindings were not a source of extra work, as the operation was performed on a cutter grinder employed on this class of work.—*Machinery.*

ELECTRIC WIRING SYSTEM FOR FACTORIES.

By E. Austin.

Careful Installation.

The wiring of factories in which motors and electric lighting are about to be installed is a matter which demands careful consideration. Bad workmanship, or the use of a wiring system that is

Fig. 1. A Continuous current Motor wired with Helsby Cables connected directly to the Brush Gear.

unsuitable for the purpose, may lead to no end of trouble and expense. A wiring system that is quite suitable for one place may be totally unsuited for another, and one of the first things to be done when about to instal electric lighting and motors, is carefully to consider the prevailing conditions. In some factories, for instance, there are destructive fumes and gases, and unless special precautions are taken, the wiring system may come to grief. In general engineering works, adequate mechanical protection of the wirings is, as a rule, the main thing to be aimed at, and when motors take large currents, say 50 amperes and upwards, and when the motors are located in different buildings, steel tape armoured, lead covered paper insulated cables are often used, the cables being cleated to walls, etc., or buried in the ground. With the aid of special junction and terminal boxes, the ends of cables can be sealed in a manner that prevents the access of moisture to the paper insulation, and from these boxes short lengths of rubber or other cables can be run to the motors, as shown in Figs. 1 and 2. In dry places the free ends of paper insulated cables can be protected with special insulating tape. Some examples of the use of lead covered paper insulated cables cleated to walls are shown in Fig. 3.

Steel Armouring.

Cables with steel armouring enable a system to be very easily earthed, for the armouring can be used as an earth conductor by joining it up at several points to a water main or earth plate. Steel armoured cables are, of course, very suitable for use in places where there is considerable risk of mechanical damage, but ordinary rubber insulated braided cables are often used where the conditions are favourable. The cables may be cleated to walls, etc., by means of wood or porcelain cleats, or be supported on knobs at bends. When it is necessary to pass the cables through walls, use is made of special tubes which are made in various patterns. For leading cables into buildings, it is customary to use tubes which are bent at one end, so that the bent part can be turned downwards to prevent

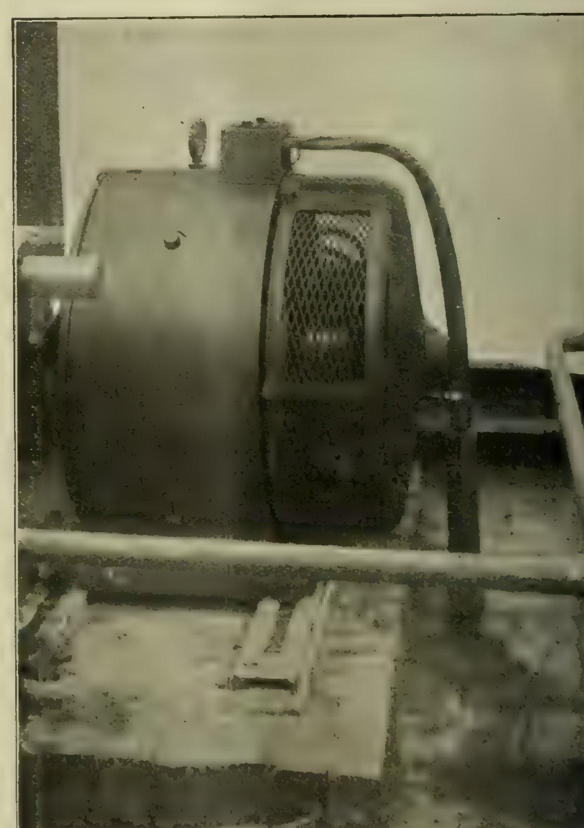


Fig. 2.—A Motor wired with Helsby Cables carried to a top Terminal Box.

the entrance of water. Special bushes are also used for leading the wires into fuse and switch cases. The practice of cleating wires to walls, etc., is, of course, a cheap system of erection. It is important, however, that when ordinary V.I.R. cables are used, they should not touch the walls or metal objects, such as bolts, etc., and in some cases it may be necessary to offset the cables by means of wood packing pieces placed behind the cleats. The cables should also be properly strained, for, if allowed to

sag, the wiring presents a very bad appearance. Of course, the use of the ordinary V.I.R. cables is only permissible when they can be placed where there is no risk of mechanical damage or damage due to oil and moisture.

Steel Conduit System.

In many works where the motor currents are not excessive the steel conduit wiring system is adopted.

Fig. 3.—Fuse Board wired with Helsby Cables.

The steel conduits in which the V.I.R. cables are placed may be enamelled inside and out or galvanised when erected in places where there is dampness. Screwed conduit should always be used for factory service, for this makes a much sounder job than plain conduit, and owing to the good contact at the screwed joints the conduit can be made to act as an earth conductor for earthing the whole system. With the aid of special earthing clips the conduit is connected to a water main or earth plates, so that it is impossible for any of the metalwork to attain a potential above that of the earth. The conduits may be attached to walls, etc., by means of saddles or clamps, the wires being pulled in after the conduits have been fixed. Plain conduits without screw threads at the ends simply fit into sockets with a special gripping device, but while these conduits are more easily erected than screwed conduits for factory work, at any rate they are not nearly so satisfactory as screwed conduits, which, when erected, are much more robust and less liable to come to grief. With the screwed conduit system use is made of screwed sockets, inspection tees, and branch fittings into which the tubes are screwed. It is obvious, of course, that it may sometimes be advisable to adopt two different wiring systems in the same factory. Where there is no risk of damage of any kind it may pay to use ordinary V.I.R. cables cleated to walls, etc, whilst in other parts of the factory, where less favourable conditions prevail, armoured cables or V.I.R. wires in conduits might possibly be used. The practice of enclosing wires in wooden casing is, of course, an old one, but it is still used for lighting in private houses. For factory work, however, steel conduit is infinitely superior.

The C.T.S. System.

The C.T.S. wiring system, patented by the St. Helens Cable Co., involves the use of C.T.S. wires having a special covering known as cabtyre sheathing, consisting of a rubber compound applied under high pressure. This sheathing will withstand the most arduous conditions met with, but at the same time the wires and cables are very pliable and easily handled. The system is not only applicable to engineering works, but to chemical works, laundries, dyeworks, powder works, paper mills, etc. In fact, the system will withstand the most destructive fumes or extreme dampness. Although primarily designed to withstand such arduous conditions, the C.T.S. system is now being extensively used for wiring in ordinary situations where it forms a very neat, strong, and cheap job. Such cables are made with

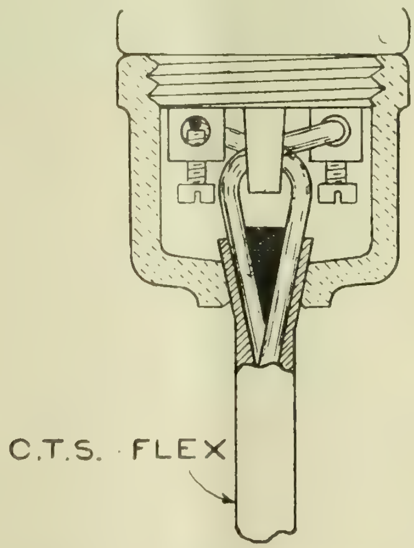


Fig. 4.—Method of taking the strain off C.T.S. Wires.

any number of cores and of any size. The erection of the wires is carried out in a very similar manner to ordinary lead-covered wires, that is to say, they are saddled directly to walls, etc. Special fittings, such as junction boxes, distribution boards, etc., are supplied for use in places where there are chemical fumes or other corrosive influences, but in other cases ordinary fittings are used. For supplying current to portable electric tools and portable lamps used in connection with

engineering operations, C.T.S. wires are admirably suited. Workshop flexible cord attached to portable hand-lamps, etc., is usually troublesome, as the conductors are constantly breaking, whilst the braided cotton covering soaks up water and oil. The C.T.S. wires, however, are in every way satisfactory, and

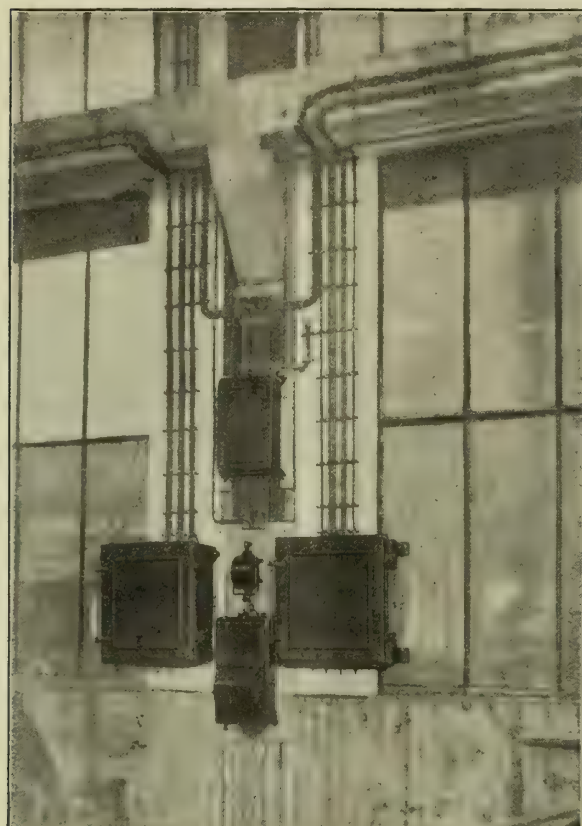


FIG. 5.—C.T.S. WIRES INSTALLED IN A FACTORY.

are now widely used in connection with the operation of all kinds of portable tools, such as drill grinders, lifting magnets, etc. A novel method of taking the strain off the wires when used for supplying current to portable tools, etc., is shown in Fig. 4. At the end of the wire which passes into the ceiling rose, or other fitting, a short wooden match stick is inserted between the two insulated conductors, thus forcing them apart and forming a wedge so that the wires are not likely to be pulled out of the terminals, because the strain is taken on the sheathing.

Application to Lighting.

The system is widely used for lighting, as well as for power work, and is specially mentioned in the I.E.E. wiring rules as being suitable for use without further protection. Illustrations showing the application of the C.T.S. wires to factory and office use are shown in Figs. 5 and 6. In offices or other buildings the wires may be concealed under floors, run down partitions, and behind wainscoting, or, if desired, run on the surface. They can also be buried in plaster or be laid directly in the ground. The fittings employed in places where exceptionally arduous conditions are met with were specially designed by the St. Helens Cable Co., and differ from ordinary corrosion-proof fittings. Ceiling roses for use in places where fumes and other destructive conditions prevail are made of porcelain, and have a sealing chamber divided by partitions to separate the positive and negative poles. The chamber is filled with a semi-liquid material of an insulating and waterproof nature, so as to preclude all possibility of corrosive gases or vapours acting upon the wires. The outer cap of the ceiling rose is filled with the sealing liquid, and then screwed on to the fixed portion in the ordinary manner, when the ends of the wires are completely protected from all atmospheric influences. The same principle is adopted in the case of junction boxes, as shown in Fig. 7. The special tumbles switches used in damp and similar places are made of porcelain or galvanised iron, the latter being adopted when there is risk of mechanical injury. The switch is contained in a chamber separated from that which contains the connecting terminals for the wires, thus enabling the wireman to connect up the switches, and to deal with the ends of the wires without interfering with the switch mechanism. The sealing of the ends of the wires and switch terminals is done by filling up the top chamber of the switch with the special semi-

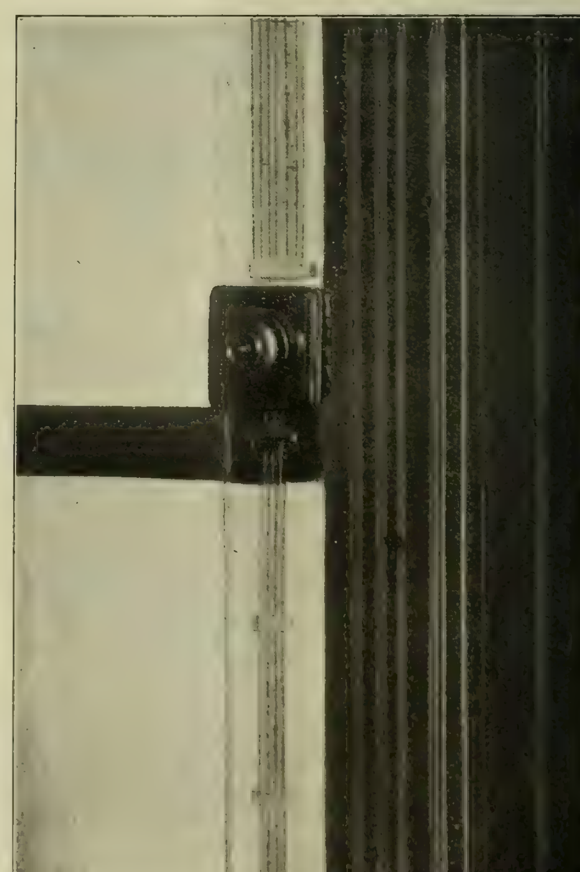


FIG. 6.—C.T.S. WIRES INSTALLED IN AN OFFICE.

fluid compound previously referred to, and when the top cover of the switch is screwed on, the compound is forced up the leading-in wires, thus giving a long sealing path. No ordinary packing glands are used. Other special fittings used with the C.T.S. wiring system in corrosive situations are a

corrosion-proof lampholder and wall-plug. Special entrance glands are also made for use in connection with distribution boards, main switches, fuse and wall-plugs having iron cases. They are also useful for connecting up any special apparatus, and provide a convenient and reliable method of bringing the wires and cables into any of the above accessories, for they form an air-tight joint and prevent fumes entering main switch and other cases and attacking the wires. The entrance holes

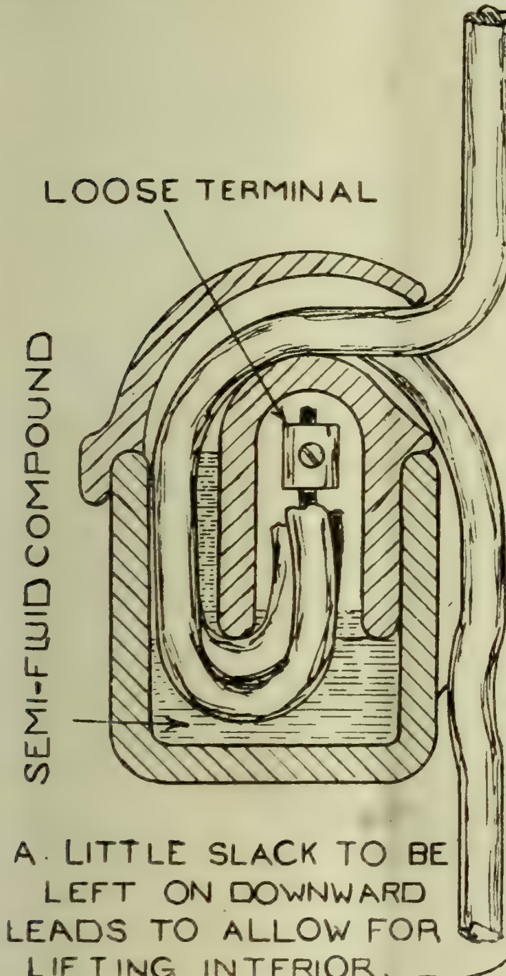


FIG. 7.- A C.T.S. JUNCTION BOX.

in the glands are sufficiently large to allow the wires to enter easily, but when they are screwed down a rubber ring is compressed, and an air-tight joint is formed. Under exceptional circumstances a small quantity of Chatterton, or other similar compound, is run round the wires passing through the glands as an extra safeguard. Special rubber washers are supplied for fitting between the glands and case into which they are screwed. Distribution boards may be of the ordinary iron-clad pattern, having heavy cast-iron cases with hinged fronts, but in places where corrosive conditions exist the cases are galvanised. The cases of main switches and fuses also conform with the requirements enumerated for distribution boards.

Stannos Wiring.

The Stannos wiring system is another cheap wiring system suitable for factory and office lighting. The wires used are rubber insulated, and have an outer metallic sheathing, which not only affords protection against mechanical injury, but also in the case of concentric wiring acts as a return circuit. The practice of using the outer sheathing as a return conductor can be adopted when the supply is an alternating current one, and when the building is supplied with current through a double-wound transformer. The sheathing can also be used in this manner when the supply is obtained from a private generating plant, or when earthing on the consumer's premises has been approved by the Board of Trade. The conductors consist of single or stranded tinned copper wires, and they are insulated with pure vulcanised indiarubber and two layers of paper, and then lapped round twice by a closely-compressed sheet of tinned copper, and the whole is made homogeneous by a special process. Of course, when the outer sheathing is used as the return conductor, only one insulated wire need be run for each circuit. The wires can be fixed by means of buckle clips, which are attached to walls, etc., by means of nails or screws. Special water-tight fuse and distribution boxes, etc., are supplied for use in damp and other places where adverse working conditions are met with. For concentric wiring it is only necessary to use a single-pole fuse-board, the fuse controlling the inner conductor. The outer covering affords ample mechanical protection, and the system has proved very successful in connection with the wiring of buildings of varous kinds.

The Henley System.

Still another cheap surface wiring system is the Henley system. This system, like the Stannos system, covers two classes of wiring, *i.e.*, earthed concentric wiring and twin wiring. The former is, of course, the most economical, and can olways be used when current is supplied through a double-wound transformer, or where earthing on the premises has been approved by the Board of Trade. The twin system is intended for other conditions. The cable used in connection with the earth concentric system has an outer or return conductor of copper tape whilst the inner conductor is composed of tinned copper wires, insulated from the outer conductor with pure vulcanised rubber taped with proofing tape, and the whole being vulcanised together. The outer copper tape conductor is wound round the core spirally, and is sheathed with a solid drawn tube composed of a special alloy. For fixing the wires in damp places, special clips are used. The Henley twin system of wiring can be used for either direct or alternating current, and when the current is drawn from public supply mains or from a private plant. Twin or three-core cables are used, and a solid-drawn tube of special alloy is employed as the outer covering, just as in the case of the single wires used in connection with the concentric system. The same kind of saddles and link clips are also used. Of course, it is essential, in order to obtain a perfectly safe and sound installation, carefully to bond and efficiently earth the metal sheathing of the wires, and this is done by means of special bonding strips at the distribution boards. Ordinary lead-covered wires are sometmes used for factory wiring, but they do not, of course, afford the same mechanical protection as the wires that have been described.

THE TRANSFORMATION RANGES OF STEEL.

In general, carbon steel during the process of heating goes through three changes, commonly known as the AC1, AC2, and AC3 transformations.

The AC1 transformation is said to be due to the carbon going into solution. This change is, of course, entirely absent in the case of pure iron. When the carbon content is high, there is a considerable absorption of heat at this transformation, giving rise to the phenomenon of decalescence.

The A.C.2 transformation is said to be due to the iron passing from the crystaline to the amorphous condition. The change is accompanied by a very slight absorption of heat, which, however, can only be detected by very refined methods of investigation. The transformation is accompanied also by a complete loss of magnetic susceptibility in the steel.

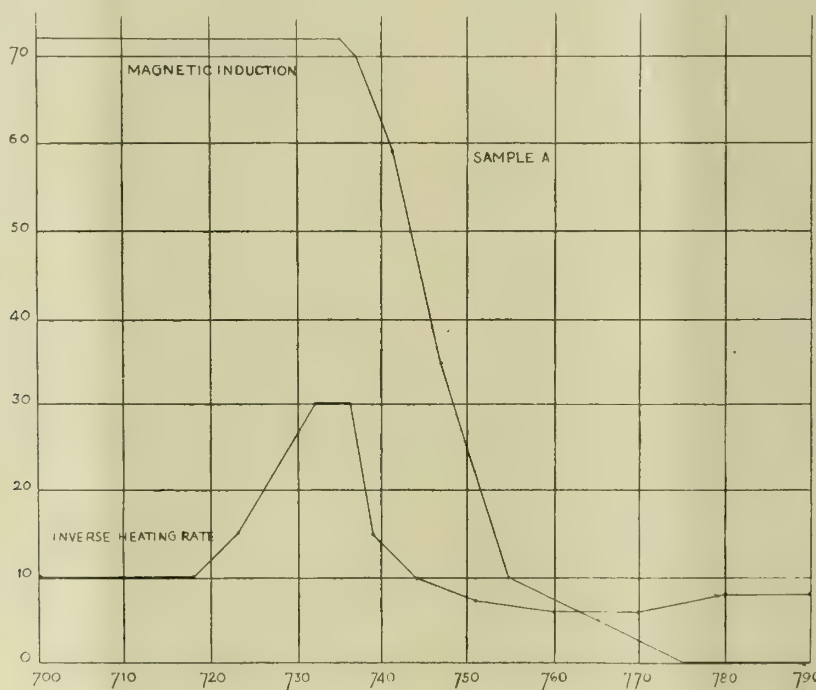
The AC3 transformation is said to be due to absorption of small masses of pure iron into the general body of the steel. This is also accompanied by the absorption of a minute amount of heat.

The AC3 transformation only takes place when there is an excess of iron in the steel; that is, when the steel contains less than 0·9 per cent of carbon.

Often these three transformations are spoken of as one (AC123) in the case of high-carbon steels, as AC1 and AC2 overlap and cannot be distinguished by purely thermal means.

AC1 and AC2 can, however, be easily separated, by noting the temperature of decalescence (AC1) and the temperature at which the steel loses its magnetic susceptibility (AC2).

As a rule, the works metallurgist has only the means of determining AC1. It is very customary to assume that the completion of the AC2 transformation takes place about 10 deg. Cen. higher than the termination of the AC1 range. This, however, it will be shown, is an assumption which is very far from being justified.



Now, the correct quenching point for steel is the termination of the AC2 range. It will be seen therefore how important it is that this point should be ascertained with exactitude. A number of steels have been examined, and it has been found that the difference between the completion of the AC1 and AC2 ranges is not 10 deg. Cen., but varies from 15 deg. to 35 deg.

The method of testing adopted has been as follows: A specimen of steel is prepared about 3 in. long by ½ in. in diameter. Two grooves are turned on the specimen, and eureka and nickel-chrome wires are twisted round these grooves respectively, so that the steel itself forms part of the thermo-couple circuit. This ensures that the temperature measured will be the actual temperature of the steel and not something else.

The specimen is heated fairly slowly in a Wild-Barfield radiation furnace, fitted with pyroscopic detector and alternating current indicator.

The decalescence is shown by taking the time that the steel takes to rise through a given temperature with alternate stop watches.

The pyroscopic indicator has a scale which is divided proportionally to the voltage induced in the detector winding, and therefore shows directly the magnetic induction in the steel.

It will be sufficient for our purpose to show the results obained with three representative steels.

The analyses of these steels are as follows:—

	A	B	C
Carbon	·65%	·912	1·12
Silicon	·094%	·094	·084
Manganese	·33%	·340	·22
Sulphur	·008%	·017	·005
Phosphorus	·017%	·072	·017

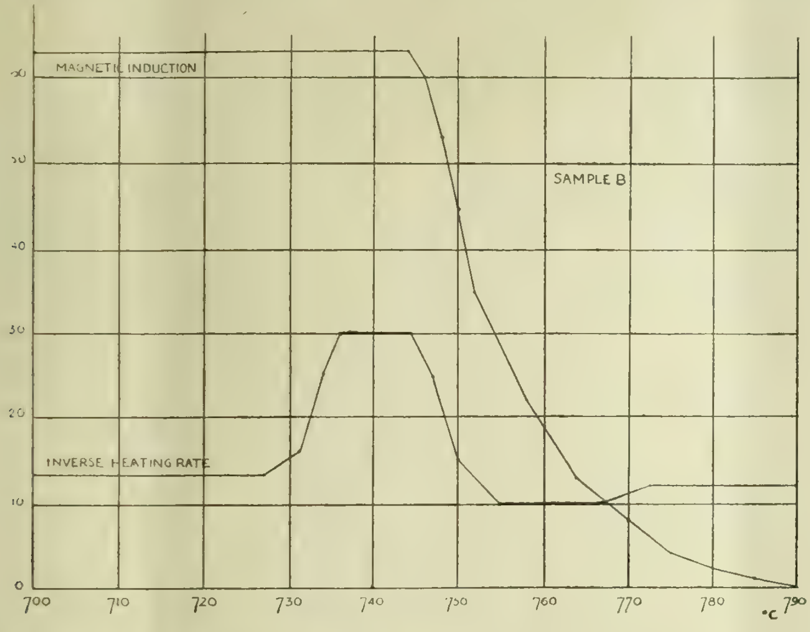
Now, referring to the figures, in each case the lower curve shows the effect of the AC1 transformation on the heating rate, and the upper curve shows the loss of magnetic susceptibility on the steel passing through the AC2 transformation.

The results may be tabulated as follows:—

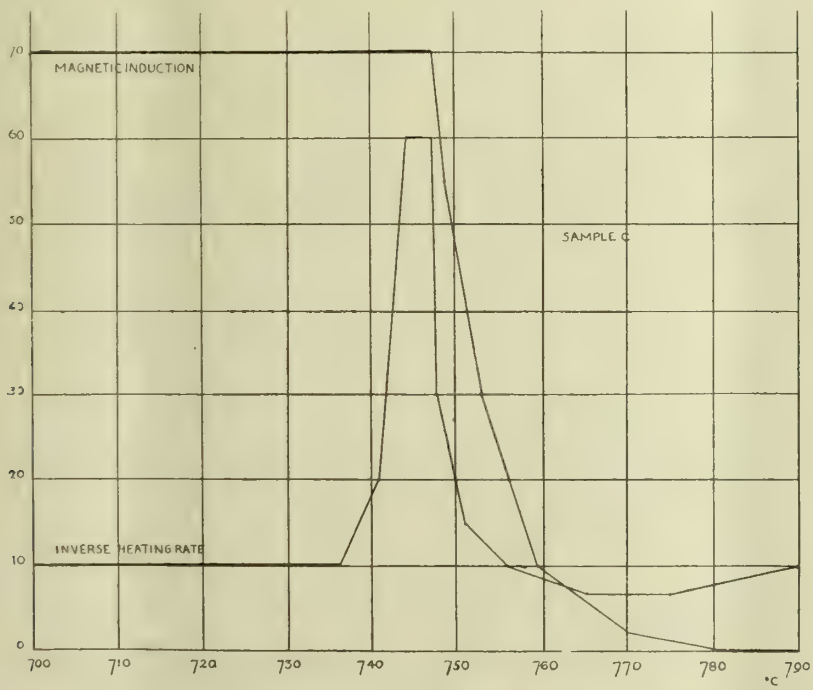
	AC1.		AC2.
A	718–760	...	735–775
B	727–755	...	744–790
C	736–765	...	747–780

quenched, according to the declaration of the pyroscopic detector.

These curves clearly show that the use of the pyroscopic detector, in preference to a decalescence test made in the works laboratory is not merely a convenience, but is also a necessity if really good results are to be obtained, *i.e.*, fine grain, high resistance to wear, mechanical strength, the best cutting power, etc.



It will be noticed that the AC2 commences just as AC1 has passed its maximum. The most important point to observe is, however, that in the two cases the finish of AC2 is 15 deg. above the finish of AC1, but in the third case it is as much as 35 deg. above AC1.



Specimen B was quenched at a temperature of 765, and was found, when tested with the magnetic sclerometer to have only about half the coercive force (hardness) that was obtained when it was

NEW DOCKS IN ARGENTINA.

A Bill has now been placed before Congress for opening a credit of 3,202,000 pesos for the purpose of constructing floating docks on the Parana, the Uruguay, and Paraguay, with a view to removing the present difficulties attending the loading and unloading of vessels. The construction of these docks is regarded as very urgent. They would number 18.

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(*Continued from page 226.*)

The calculated reactions W for the external load are 1.000, 1.221, 1.296, 1.327, 1.341, 1.363, 1.376, 1.385 and 1.363 respectively. The calculated stiffness, taking E as 29×10^6, is 1,057 lbs. per inch deflection. The test loads of an actual spring were 1,070 lbs. at 1 in. deflection, 1,565 lbs. at $1\frac{1}{2}$ in., 2,070 lbs. at 2 in., 2,580 lbs. at $2\frac{1}{2}$ in., and 3,100 lbs. at 3 in., which agree within the limitations of practice with the calculated stiffness.

The fundamental constants for this spring, obtained as indicated in our second paper, are found to be as follows:

n	A_n	B_n	C_n	W_n
1	.0032149	.0002149	.8187	1.000
2	....	.0003337	.9419	1.221
3	.0002149	.0005124	.9768	1.296
4	.0003518	.0007434	.9895	1.327
5	.0006217	.001024	.9840	1.341
6	.0003518	.001315	.9901	1.363
7	.0006217	.001648	.9935	1.376
8	.0008999	.002031	.9062	1.385
9	.001360	.002203	.7442	1.528
10	.0008999	.001785		1.861
11	.001360			
12	.001829			
13	.002530			
14	.001829			
15	.002530			
16	.003239			
17	.004229			
18	.003239			
19	.004229			
20	.005169			
21	.006401			
22	.005169			
23	.006401			
24	.007640			
25	.009212			
26	.007640			
27	.009212			
28	.01079			
29	.01275			
30	.01079			
31	.007291			
32	.008448			
33	.009859			
34	.008448			

In the above table it will be noticed that values for C_n are given for both 8 and 9 as the value of n. When dealing simply with the reactions due to the external load, the top compound plate is considered as a single plate with a moment of inertia equal to the sum of the moments of inertia of the separate plates, as has been mentioned previously, but when we are dealing with the nipping reactions, it is necessary to consider every plate separately: that is, as in the present case, we must consider the partial spring obtained by adding the 9th plate to the 8-plate partial spring, and also consider the complete spring obtained by adding the 10th plate to the 9-plate partial spring. As the 9th and 10th plates are of the same length, then for calculations concerning the external load they need be considered as only one plate, but, as indicatd above, for the nipping reactions they have to be taken separately as in the previous table.

The nipping reactions may now be tabulated as follows:—

n	N_n	P_n	P_n (total)
1	.031	7	420
2	.031	35	505
3	.062	50	499
4	.062	47	460
5	.125	53	417
6	.187	60	370
7	.312	71	313
8	.437	129	244
9	.437	127	127

In the preceding table, the P's are, of course, those calculated by the successive application of equation (55). The P's (total) are determined thus: P_9, or the reaction produced on adding the 10th plate to the 9-plate partial spring, is equal to 127 lbs.; the relation between a load on the end of the 9-plate partial spring and the reaction between the 9th plate and the 8-plate partial spring is $W_8/W_9 = C_8 = .9062$ and $127 \times .9062 = 115$. Adding this to the nipping reaction of 129 lbs. produced when adding the 8th plate to the 7-plate partial spring is $W_8/W_9 = C_8 = .9062$ and $127 \times .9062 =$ the 8th and the 7th plates will be 244, as given in the table. Similarly, the total nipping reaction between the 7th and the 6th plates is $244 \times .9935 + 71 = 313$ lbs. A continuation of the same process determines all of the nipping reactions, as given in the table above under P_n (total).

We may here note that these nip calculations determine the amount of the camber to be given to the master leaf in forming. In the case under discussion it is seen that the final total nipping load on the master leaf or 10th plate is 127 lbs. and the deflection produced by this load is $127 \times .009859 = 1.25$ in., and therefore the master leaf must be formed with a camber $1\frac{1}{4}$ in. less than the desired camber for the assembled spring; this was actually the case for the spring measured.

We may now say that, in the absence of the theory as developed in the previous papers, the present study of nip and nip deflection would not have been possible, but that with the application of this theory very many results which have been observed in practice may now be accounted for. Other results of practical importance, but somewhat foreign to the present paper, have been predicted from the theory and have been confirmed in actual use.

Endurance of Plate Springs.

We now enter into the final stage of the present exposition, which is that of the "life" or "endurance" of the plates composing a spring under the stress variations experienced in actual service.

In the past the commercial value of a spring or its "strength" was usually measured by the static load it would support without taking a permanent set, or else, as was the practice of the French spring makers—and amongst them, the most renowned of all, the Etablissements Lemoine of Paris, France—by the elastic elongation of the material. It was believed formerly, due to the teachings of Mons. Lemoine, and is still perhaps held to be the case by some engineers, that the greater the elastic elongation or the higher the elastic limit of the material, the greater is the "strength," and also as a result the endurance or life of a spring. We have found, however, that this condition does not necessarily hold, and at least it is certain that there is no linear relation between the elastic limit of the material and the life of a spring.

It is a well-known and accepted fact in applied mechanics that any piece of material will withstand a considerable number of applications of a load (within the elastic limit) provided the said load does not produce stresses varying in sign from positive to negative—tension to compression—and that when the load produces stresses varying in sign, then the material subjected to such alternating stresses breaks down more rapidly. For instance, as a practical illustration, if we have a piece of metal bar and wish to break it by hand without exerting any great force, we bend it back and forth, so as alternately to produce positive and negative stresses, and this procedure rapidly breaks the bar, even with a ductile metal which will bend double on itself—lead, for instance.

The stresses in the plates of a plate spring due to the nip are not of the same sign in all of the plates, and the amount of the stress, and in some cases its sign, will change when the external load is applied. In a spring composed of more than two plates we may find, under certain conditions of the loading, plates, or parts of plates with zero stress—that is, the positive effect of the external load may exactly neutralise the negative effect of the nips; this is of great importance.

(To be continued.)

COAL CONSERVATION AND ELECTRIC POWER SUPPLY.*

(Continued from page 231).

Importance of Increasing the Available Power per Worker Employed in Great Britain.

As was said in my opening remarks, the question of cheap and efficient power supply to our factories and workshops is one of the most important problems of reconstruction. Everyone is agreed that our colossal war debt can only be paid off by vastly increasing the productivity of labour, and it is only by increasing the amount of power used in industry per worker employed that the net output of the individual worker can be increased. By *net* output is here meant the value added by the worker to the material he operates upon (*i.e.*, it is the *selling* value at the factory *minus* the cost of the material used).† For it is clear that, except in a country ruled by Mad Hatters, the worker cannot be paid in wages more than a certain proportion of the values he adds to the materials which he handles: and that if he already receives such fair proportion he has no justifiable ground for demanding, nor can he be paid, more unless and until he increases his *net* output. Hence it follows that if the net output and, consequently, real wages are to be increased, more power per worker must be employed in industry. The cure for low wages is more net output per worker, and this involves more power per individual worker. The economic needs of our day, without which we cannot hope to recover even a measure of our former prosperity are: (1) cheap food, (2) better housing, (3) higher scientific and technical training, (4) more motive power (and relatively cheap coal), (5) a reorganised transport and distribution system; and (6) a sound and equitable system of public taxation, combined with a drastic curtailment of all unproductive public expenditure.

Before the war, each worker in the United States had on the average 56 per cent more power at his disposal than his *confrère* in Great Britain. Indeed, if industries in which comparatively little power per worker is used be eliminated, it is probable that in those industries where power is mostly used the American worker used twice as much power as his British competitor. Hence, his *net* output was much greater, and his real wages were higher than he would have received over here. The American artisan is better educated, and understands that he benefits by increased output, and accordingly he works for it. Unfortunately, the British working man thinks differently: his ideas seem to be (1) that the sum total of material requirements of his market is a fixed quantity, and therefore that no more than a certain quantity of commodities can be absorbed within a given time; (2) that if an individual worker produces, in a given time, more than a certain *net* output he does so to the detriment of his fellows; consequently, (3) that the *net* individual output ought to be limited by rules, and that no worker shall be allowed to exceed such limit. Needless to say, however, the results of such a policy would be ruinous to all concerned, and most of all to the manual workers themselves.

Also, there can be no doubt but that, before the war, power was generated on the average very inefficiently in our mines and factories. It is impossible to give a precise figure for coal consumption per brake-horse-power produced, because, unfortunately, the data on which to base such an estimate are wanting. But there are grounds for believing that it was probably not much less than 5 lb. per brake-horse-power-hour. This would mean that on the average we are only utilising about 4 per cent of the available energy in the coal burnt, the other 96 per cent being wasted. This alone ought to make us profoundly dissatisfied with the present system.

Personally, I have always believed in the principle of co-operative power production in a densely-populated industrial country such as ours, and if such principle is accepted there seems to be no other really effective way of putting it into operation except through the medium of electricity.

Seeing, however, that the claims of electricity in this connection are being controverted in certain quarters, I will ask your permission to make a digression at this point in order to explain precisely where I stand in the matter.

Last week Sir Dugald Clerk endeavoured from this platform to delimit the respective fields of gas and electricity in regard to lighting, heating and power. With what he said in regard to both lighting and heating I entirely agree; but I thought he rather obscured the real issue in regard to power, and therefore I think it all the more necessary for me to make it clear.

The partisans of gas are, at the moment, endeavouring to dispute the claims of electricity in regard to power by using an argument which in my opinion is palpably unfair. They point with pride to the

* Lecture delivered before the Royal Society of Arts by William Arthur Bone, D.Sc., Ph.D., F.R.S., professor of Chemical Technology at the Imperial College of Science and Technology, London.

† According to the last census of production the average "net output per worker" in 1907 was only £102 per annum, out of which had to be paid not only the workers' wages, but also establishment charges and the interest on capital.

marked contrast between the 70 per cent thermal efficiency achieved in the Metropolitan Gasworks (*vide* my previous lecture) and the highest efficiency (alleged to be 13 per cent) achieved by any electric supply undertaking in the Kingdom. But, I venture to ask, is there any connection, or basis or comparison possible between such figures? The one relates to a ratio between the combined potential energies of the coke, tar, and gas sent out of one kind of factory and that of the coal taken in. The other relates to the ratio of electric energy (power) sent out of another kind of factory to that of the coal used in producing it. There is a great difference between these two ratios, which are not directly comparable because, whilst they postulate one and the same initial substance (coal), they contemplate two entirely different end products. The one starts from coal and ends merely with coke, tar and gas; the other, starting also from coal, ends with electricity. The journey in both cases begins, as it were, at King's Cross; but in the one case it ends at Peterborough, and in the other at Edinburgh. What signifiance, then, is there in attempting to compare the expenditures of energy in the two cases as though they related to similiar distances traversed?

Speaking from a perfectly disinterested and independent standpoint, I deplore the importing of partisanship into the determination of so vital an issue as that of our national power policy. We are not likely to reach a sound conclusion in the matter if it is made the battlefield of the supposed rival interests of gas and electricity and to be determined by their relative powers of influencing either the Board of Trade or the course of legislation in Parliament. Unfortunately, the gas industry is, in this matter, inordinately jealous of its younger competitor; and instead of frankly recognising the undoubted claims of electricity in regard to power, it is pursuing what seems to me to be an obscurantial policy which, if successful, would defeat the public interest. We shall never attain to a well-balanced policy of "coal conservation" until the narrow partican spirit and outlook is abandoned and both gas and electricity are regarded as *complementary* instead of *rival* public utilities.

I do not suppose that Sir Dugald Clerk would contend that it is possible to convert coal into electric energy *viâ* coke, tar, and gas with a materially greater thermal efficiency than by its direct combustion in the first instance in the boilers of a turbo-driven electric power station. It seems to me that the real signifinance in regard to the power question of such figures as those referred to is somewhat as follows:—

(*a*) Coal can be carbonised on a large scale in gas works at an expenditure of not more than 30 per cent of its energy.

(*b*) The resulting coke and gas could then be used for generating electricity with an "over-all" efficiency of (at the most) 22·5 per cent. So that the whole conversion coal $\longrightarrow$ coke and gas $\longrightarrow$ electricty, would imply an "over-all" efficiency of $70 \times 0·225 = 15·75$ per cent at the most.

(*c*) Alternatively, the coal could be directly converted into electricity at an over-all efficiency of, *at the least*, 17·5 per cent (I do not accept 13 per cent as being the best actual achievement in power-station work, for reasons which will be apparent later).

(*d*) It is then preferable, for the sake of the by-products obtainable on carbonising the coal in accordance with (*a*), to adopt the combination (*a*) + (*b*) instead of the direct process (*c*)?

The correct answer to (*d*) at the present moment, and in the light of *present* circumstances, would, I believe, be in the negative because (as will be explained later) electricity can be generated with a 17·5 per cent thermal efficiency from low-grade coals which it would never pay to carbonise at all in gasworks. Indeed, I regard the economic functions of the gasworks and the electric power station to be quite distinct, and in no sense really competitive or antagonistic. The function of the gasworks is to convert high-grade coal into gas, coke, tar, ammonia and other valuable products, whereas that of the power station is to convert low-grade coals into electric energy

I am convinced (*a*) that the cheapest and best means of supplying the public with *heat energy* is to distribute it in the form of *gas*, and (*b*) that, if public *power* supplies are required, the energy will be best distributed as *electricity* and not as gas. Whether, in transforming coal into electricity, a gas engine or a steam turbine ought to be employed as the prime mover is entirely a subsidiary matter. The real question is, will the electric motor be the pivot of our future industrial power system or not? Personally, I think it will. If so, then our chief concern at the moment must be to ensure that the nation adopts a sound policy in regard to the coming reorganisation of its electric power system.

(*To be continued.*)

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from page 176.)

Conditions of Success with Powdered Fuel.

The conditions of success in burning powdered fuel in steam boilers appear to the writer to be as follows:—

1. The fuel should be absolutely dry, or as nearly so as can be arranged, when it issues from the burner into the boiler furnace.
2. All the ash, all the incombustible matter should have been removed from the fuel before it is delivered to the burner; and success will, it appears to the writer, be in proportion to the extent that this is accomplished.
3. The conditions under which the powdered fuel is delivered to the boiler furnace should be as nearly those under which gas for gas firing is delivered as possible; and, again, it appears to the writer that success will be in proportion as this is accomplished.

Of the conditions, the second appears to the writer to be the most important, and, at the same time, the most difficult to accomplish. It will be remembered that firing with powdered coal is quite different to firing in an ordinary boiler furnace; and, again, it is quite different to firing by gas, in the important matter of the ash. Ash is the incombustible portion of the coal, it makes itself quite objectionable enough in the ordinary boiler furnace; but there, by proper stoking,

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 73 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 2 2	13 0 4	0 19 2 16	1 6 0 8	1 12 2 10	1 19 0 12	2 5 2 14	2 12 0 16	2 18 2 18	0
1	0 2 17	7 0 19	13 2 21	1 0 0 23	1 6 2 25	1 13 0 27	1 19 3 1	2 6 1 3	2 12 3 5	2 19 1 7	1
2	1 1 6	7 3 8	14 1 10	1 0 3 12	1 7 1 14	1 13 3 16	2 0 1 18	2 6 3 20	2 13 1 22	2 19 3 24	2
3	1 3 23	8 1 25	14 3 27	1 1 2 1	1 8 0 3	1 14 2 5	2 1 0 7	2 7 2 9	2 14 0 11	3 0 2 13	3
4	2 2 12	9 0 14	15 2 16	1 2 0 18	1 8 2 20	1 15 0 22	2 1 2 24	2 8 0 26	2 14 3 0	3 1 1 2	4
5	3 1 1	9 3 3	16 1 5	1 2 3 7	1 9 1 9	1 15 3 11	2 2 1 13	2 8 3 15	2 15 1 17	3 1 3 19	5
6	3 3 18	10 1 20	16 3 22	1 3 1 24	1 9 3 26	1 16 2 0	2 3 0 2	2 9 2 4	2 16 0 6	3 2 2 8	6
7	4 2 7	11 0 9	17 2 11	1 4 0 13	1 10 2 15	1 17 0 17	2 3 2 19	2 10 0 21	2 16 2 23	3 3 1 25	7
8	5 0 24	11 2 26	18 1 0	1 4 3 2	1 11 1 4	1 17 3 6	2 4 1 8	2 10 3 10	2 17 1 12	3 4 0 14	8
9	5 3 13	12 1 15	18 3 17	1 5 1 19	1 11 3 21	1 18 1 23	2 4 3 25	2 11 1 27	2 18 0 1	3 4 3 3	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6·08	12·16	18·25	24·33	1 2·42	1 8·5	1 14·58	1 20·67	1 26·75	2 4·84	2 10·92	2 17	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 73 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 5 0 20	6 10 1 12	9 15 2 4	13 0 2 24	16 5 3 16	19 11 0 8	22 16 1 0	26 1 1 20	29 6 2 12	0
10	0 6 2 2	3 11 2 22	6 16 3 14	10 2 0 6	13 7 0 26	16 12 1 18	19 17 2 10	23 2 3 2	26 7 3 22	29 13 0 14	10
20	0 13 0 4	3 18 0 24	7 3 1 16	10 8 2 8	13 13 3 0	16 18 3 20	20 4 0 12	23 9 1 4	26 14 1 24	29 19 2 16	20
30	0 19 2 6	4 4 2 26	7 9 3 18	10 15 0 10	14 0 1 2	17 5 1 22	20 10 2 14	23 15 3 6	27 0 3 26	30 6 0 18	30
40	1 6 0 8	4 11 1 0	7 16 1 20	11 1 2 12	14 6 3 4	17 11 3 24	20 17 0 16	24 2 1 8	27 7 2 0	30 12 2 20	40
50	1 12 2 10	4 17 3 2	8 2 3 22	11 8 0 14	14 13 1 6	17 18 1 26	21 3 2 18	24 8 3 10	27 14 0 2	30 19 0 22	50
60	1 19 0 12	5 4 1 4	8 9 1 24	11 14 2 16	14 19 3 8	18 5 0 0	21 10 0 20	24 15 1 12	28 0 2 4	31 5 2 24	60
70	2 5 2 14	5 10 3 6	8 15 3 26	12 1 0 18	15 6 1 10	18 11 2 2	21 16 2 22	25 1 3 14	28 7 0 6	31 12 0 26	70
80	2 12 0 16	5 17 1 8	9 2 2 0	12 7 2 20	15 12 3 12	18 18 0 4	22 3 0 24	25 8 1 16	28 13 2 8	31 18 3 0	80
90	2 18 2 18	6 3 3 10	9 9 0 2	12 14 0 22	15 19 1 14	19 4 2 6	22 9 2 26	25 14 3 18	29 0 0 10	32 5 1 2	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	32 11 3 4	65 3 2 8	97 15 1 12	130 7 0 16	162 18 3 20	195 10 2 24	228 2 2 0	260 14 1 4	293 6 0 8	325 17 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 72 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 1 20	12 3 12	0 19 1 4	1 5 2 24	1 12 0 16	1 18 2 8	2 5 0 0	2 11 1 20	2 17 3 12	0
1	0 2 16	7 0 8	13 2 0	0 19 3 20	1 6 1 12	1 12 3 4	1 19 0 24	2 5 2 16	2 12 0 8	2 18 2 0	1
2	1 1 4	7 2 24	14 0 16	1 0 2 8	1 7 0 0	1 13 1 20	2 0 3 12	2 6 1 4	2 12 2 24	2 19 0 16	2
3	1 3 20	8 1 12	14 3 4	1 1 0 24	1 7 2 16	1 14 0 8	2 0 2 0	2 6 3 20	2 13 1 12	2 19 3 4	3
4	2 2 8	9 0 0	15 1 20	1 1 3 12	1 8 1 4	1 14 2 24	2 1 0 16	2 7 2 8	2 14 0 0	3 0 1 20	4
5	3 0 24	9 2 16	16 0 8	1 2 2 0	1 8 3 20	1 15 1 12	2 1 3 4	2 8 0 24	2 14 2 16	3 1 0 8	5
6	3 3 12	10 1 4	16 2 24	1 3 0 16	1 9 2 8	1 16 0 0	2 2 1 20	2 8 3 12	2 15 1 4	3 1 2 24	6
7	4 2 0	10 3 20	17 1 12	1 3 3 4	1 10 0 24	1 16 2 16	2 3 0 8	2 9 2 0	2 15 3 20	3 2 1 12	7
8	5 0 16	11 2 8	18 0 0	1 4 1 20	1 10 3 12	1 17 1 4	2 3 2 24	2 10 0 16	2 16 2 8	3 3 0 0	8
9	5 3 4	12 0 24	18 2 16	1 5 0 8	1 11 2 0	1 17 3 20	2 4 1 12	2 10 3 4	2 17 0 24	3 3 2 16	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	0 6	0 12	0 18	0 24	1 2	1 8	1 14	1 20	1 26	2 4	2 10	2 16	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 72 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 4 1 4	6 8 2 8	9 12 3 12	12 17 0 16	16 1 1 20	19 5 2 24	22 10 0 0	25 14 1 4	28 18 2 8	0
10	0 6 1 20	3 10 2 24	6 15 0 0	9 19 1 4	13 3 2 8	16 7 3 12	19 12 0 16	22 16 1 20	26 0 2 24	29 5 0 0	10
20	0 12 3 12	3 17 0 16	7 1 1 20	10 5 2 24	13 10 0 0	16 14 1 4	19 18 2 8	23 2 3 12	26 7 0 16	29 11 1 20	20
30	0 19 1 14	4 3 2 8	7 7 3 12	10 12 0 16	13 16 1 20	17 0 2 24	20 5 0 0	23 9 1 4	26 13 2 8	29 17 3 12	30
40	1 5 2 24	4 10 0 0	7 14 1 4	10 18 2 8	14 2 3 12	17 7 0 16	20 11 1 20	23 15 2 24	27 0 0 0	30 4 1 4	40
50	1 12 0 16	4 16 1 20	8 0 2 24	11 5 0 0	14 9 1 4	17 13 2 8	20 17 3 12	24 2 0 16	27 6 1 20	30 10 2 24	50
60	1 18 2 8	5 2 3 12	8 7 0 16	11 11 1 20	14 15 2 24	18 0 0 0	21 4 1 4	24 8 2 8	27 12 3 12	30 17 0 16	60
70	2 5 0 0	5 9 1 4	8 13 2 8	11 17 3 12	15 2 0 16	18 6 1 20	21 10 2 24	24 15 0 0	27 19 1 4	31 3 2 8	70
80	2 11 1 20	5 15 2 24	9 0 0 0	12 4 1 4	15 8 2 8	18 12 3 12	21 17 0 16	25 1 1 20	28 5 2 24	31 10 0 0	80
90	2 17 3 12	6 2 0 16	9 6 1 20	12 10 2 24	15 15 0 0	18 19 1 4	22 3 2 8	25 7 3 12	28 12 0 16	31 16 1 20	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	32 2 3 12	64 5 2 24	96 8 2 8	128 11 1 20	160 14 1 4	192 17 0 16	225 0 0 0	257 2 3 12	289 5 2 24	321 8 2 8	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

or by proper working of the fire bars in the case of the mechanical stoker, the ash is dealt with, it is got rid of; it causes a loss of efficiency in the boiler, because of the quantity of heat that is absorbed in raising its temperature, and because of the obstruction it makes to the draught, if it is not properly cleared away; but it can always be cleared away, and in the latest modern boiler plant it is carried away automatically by some form of conveyor, or ejector. With gas firing there is no ash; that has been got rid of in the retort, or the gas producer. With powdered fuel, so far as the writer has been able to ascertain, there is still some ash present; and, in addition to absorbing heat, just as in the ordinary furnace, it appears to him that the ash must be deposited at some part of the system over which the hot gases formed by combustion flow, leading to the introduction of thermal resistance in different parts, between the metal heating surfaces and the hot gases, and thereby leading to inefficiency of the boiler.

Some very important information on the subject of ash has recently arrived from America. As readers know, engineers in America have been taking this question up, the burning of powdered fuel pretty vigorously; they have also been very carefully examining the effect of dirt, which, of course, means ash, in coal when used under the usual conditions in boiler furnaces. A paper was recently read before one of the Railway Associations over there on the subject. The writer pointed out that dirt gets into the coal that is brought to bank, from various causes; sometimes the shale roof comes down with the coal, and a portion of it is filled into the mine wagons; in other cases, the cutter bars of coal cutting machines, which are supposed to be cutting in the coal, drive into the fireclay which so often underlies the coal, and a portion of the clay finds its way into the mine wagons. It is pointed out in the paper, that nearly all the dirt can be removed from the coal, raising it to the condition of good lump coal, by washing the screenings, the loose portions that come to bank in the mine wagons. As mentioned above, in the United Kingdom, in some districts at any rate, care is taken to see that only lump coal is filled into the mine wagons; but, in most districts, there is a good deal of small brought to bank, and the quantity has increased since the advent of the mechanical stoker. The following figures as to the calorific value of washed, unwashed, and lump coal are instructive. Dry, unwashed screenings, that is to say, the small coal that goes through the screen, was found to have a calorific value of 8,800 B.Th.U.; washed screenings had a calorific value of 10,000 B.Th.U., and lump coal 10,500. The coal in this case was taken from a bituminous mine in the Central West district. The analyses of the ash given by the same author, of the coal in question, will be instructive: sulphur ranged from 0·64 per cent to 4·5 per cent, silica from 27 to 59 per cent, oxide of iron from 3 to 52 per cent, alumina from 9 to 31 per cent, lime (calcium oxide) from 4·5 to 31 per cent, magnesium oxide from 0 to 1·5 per cent. The fusing temperatures of the substances are even more interesting: sulphur is given as 239 deg. Fah., silica 3,227 deg. Fah., oxide of iron 2,840 deg. Fah., alumina 3,416 deg. Fah., calcium oxide 3,452 deg. Fah., magnesium oxide 3,882 deg. Fah. The percentages given above are the percentages of the ash, not of the coal, and the fusing temperatures are those of the actual substances found in the ash by analysis. The importance of these analyses and the fusing temperatures lies in the very high figures of the latter; silica, for instance, alumina, and calcium oxide require considerably over 3,000 deg. Fah. to fuse them. In the particular case under consideration the very high fusing temperature of magnesium oxide does not appear to matter very much, as the amount present is so small, but the quantities of silica, alumina, iron oxide, and calcium oxide are serious. The author of the paper gives analyses of different coals found in Illinois and Indiana; and the ash present in them ranges from 8½ to 18 per cent, with an ash content of 18 per cent, and with, say, 50 per cent of the ash of one of the very infusible substances such as silica or alumina, the matter appears to the writer to be very serious when considered in connection with the possibility of using the coal in the powdered form. The substances contained in the ash, which fuse at the high temperatures mentioned, must, it appears to the writer, be deposited on some of the heating surfaces because of the lowering of the temperature of the hot gases in their path from the burner to the chimney. What happens, as the writer understands, is, when any of these substances form part of the fuel, however finely it may be powdered, they will issue from the burner with the powdered coal; they will not contribute anything to the heat produced by combustion, but will absorb heat to raise them to the temperature of the hot gases; they will be raised to that temperature, and if it be high enough, if the unusual temperature of 3,500 deg. Fah. is attained, they will be fused, and will go forward in a more or less plastic, or liquid form. Whether they are fused or not, the fine particles of which they are composed will be carried forward with the stream of hot gases; and as the temperature of the hot gases decreases, more or less of the particles of ash will be deposited; the effect will be very similar to that on the outside of the economiser tubes, except that the deposit will be of this hard infusible substance that will be so difficult to remove.

The Possible Remedy.

The possible remedy for the ash trouble is to thoroughly clean all the coal and to abstract every particle of ash, as far as is practicable; the more thoroughly this is done, the greater is the chance of success with powdered coal firing. Coal washing has been raised almost to a fine art; there are a number of very beautiful apparatus on the market, and the writer suggests that invention should be encouraged in this direction; that if it be worth while to burn coal in the powdered form, every effort should be made to remove every particle of ash from the coal before pulverising. Without exception, the writer believes, every process of coal cleaning involves the use of water, and it leaves the clean coal with a fairly considerable amount of moisture; the finer the coal, the smaller the lumps, or the dust, the larger will be the proportion of water that will be taken up by the coal in the process of cleaning. The objection to the presence of moisture is the old one that has been so often repeated, the moisture absorbs heat to raise its temperature, convert it into steam, and, in special cases, to decompose it into its constituents—oxygen and hydrogen gases. The remedy is a very simple one; the cleaned coal should be thoroughly dried. In the latest apparatus to be placed upon the market, a rotary drier occupies an important position; the coal is thoroughly dried before

passing to the pulveriser; there is no reason whatever that the coal should not be thoroughly cleaned by washing before passing to the drier; if this precaution is taken, it appears to the writer that powdered coal properly burnt should have a very good chance of success.

If the powdered fuel contains only carbon, and any gases that the coal has held in suspension, probably in either the liquid or the solid form, the conditions of firing should be exactly the same as with gas, and the same remarks made in an earlier part of these articles with reference to the furnaces in which gas should be burnt for heating boilers applies to powdered fuel. The idea of applying powdered fuel to the ordinary furnaces of Lancashire or water-tube boilers appears to the writer to be merely a makeshift; it is allowable where it is important to utilise the existing plant, but in that case the grates should be done away with, and, as far as possible, the flues and the spaces through which the hot gases flow should be divided up, so that the mass of the flowing gases should also be divided up, and the fullest value of the heat they carry obtained from them. When powdered fuel is burnt, the resulting conditions are very similar to those when gas is burnt; the carbon combines with the oxygen to form carbonic acid gas, and if any carburetted hydrogen gas is present, it is split up into carbon and hydrogen, these both immediately combining with oxygen. The breaking up of the carburetted hydrogen gas into its components absorbs heat, but the combination of the carbon and hydrogen with oxygen, that immediately follows, liberates a very much larger quantity of heat than is absorbed by the breaking up. The result, in all cases of this kind, is, as in the case of the burning of coal in a boiler furnace, the formation of a large volume of gas, consisting of carbonic acid and nitrogen principally at a very high temperature, the temperature, of course, depending upon the efficiency of the combustion; these hot gases have to deliver up their heat to the water, or the steam, during their passage to the chimney, and the efficiency of the plant will depend upon how completely this is accomplished, as well as upon how efficiently the combustion is carried out. If the initial temperature in the combustion chamber is as high as 3,500 deg. Fah., and if the temperature of the hot gases at the chimney is only, say, 300 deg. Fah., a very high efficiency of the plant will have been attained; this can only be reached by breaking up the hot gases into a number of small streams and causing each stream to pass over a large heating surface. Some arrangement similar to that outlined for gas firing should answer the purpose.

UTILISING INDUSTRIAL WASTE.*

The problem of reclaiming waste materials is of great importance in industry. There are industries so prosperous and so well established that they thought they could ignore waste, but the war taught the great error of this policy, and one of the most important developments in industrial life is the employment of competent chemists and engineers for the purpose of checking waste and of reclaiming all that is possible. Many industries are still wasteful of metals which cannot be replaced. One example is the values which escape in industrial streams; some of these streams were found to contain so much copper from brass works that all the bacteria had been killed, not to mention the higher forms of life. The losses in this way which occurred in the United States became so great that the Government made it an offence to turn metal industrial wastes into navigable streams, and electrolytic as well as chemical methods have been devised to save the metals in solution.

* "Engineering and Industrial Management."

In the case of spent dry batteries of a certain size, popular in the United States, the manganese in such batteries is only about 25 per cent exhausted at the time the battery is too weak to remain in use, and a chemical engineer has found a way to recover this valuable material so economically that a small sum may be paid for old batteries within a radius of 150 miles of the process plant.

Conditions Promote Waste.

Manufacturers continue to use materials under conditions which promote waste. For example, zinc is volatile, and it is estimated that 6 per cent is lost in making brass castings, and 10 per cent when wrought brass is made. Enormous quantities in the form of zinc oxide remain unrecovered in motor-car tyres, to say nothing of that wasted in galvanised iron scrap, which can be recovered from clean scrap in a form ready for paint making.

The failure to recognise waste may be due sometimes to unfamiliarity with the various forms some substances may take. Silver is an example of this. In making mirrors, silver is usually deposited chemically in several coats upon clean glass. When the reducing solution is added to the silver solution, metallic silver begins to come out in all parts of the mixed fluid. It deposits upon everything with which it may come into contact, but looks like silver only in case the surface where it is deposited is glass-like in smoothness. Thus, if the silvering is done in a porcelain dish, it will become a mirror. By far the greater proportion of the silver looks like grey mud, and in some cases has been thrown away as a useless by-product. A method has been devised for chemically purifying this mud, separating it from organic matter, and again converting it into the compound from which silvering solutions are made. This process enabled the company which adopted it to save £1,000 more in one year than could have been realised if the "mud" had been sold to refiners. Methods have also been devised recently whereby a much greater percentage of the silver is deposited on the glass at a rate to ensure satisfactory results, meaning a higher percentage of perfect work, and saving in silver as well as in time.

Necessity for Experts.

Another example of industrial waste may be said to be due to the fact that in the first place a small concern attempts to make a speciality for its own use instead of buying it, and in the second place, because the management had not realised the advantage of placing its problems in qualified hands for solution. The article in question is a roller bearing; 60 per cent is discarded after all the work has been expended on it, and there is a constant fear that some of the rollers may fail in service because of defects not visible to the inspectors.

Dr. Charles L. Parsons, in his "Notes on Mineral Wastes," quotes the case of a manufacturer of steel

blades making more than 300,000 blades per day, who was able to halve his costs by engaging the services of a chemical engineer. The old practice was to harden the blades in a furnace heated by gas and blast, 65 such furnaces being operated day and night, and requiring the labour of 15 men. This was changed to six electrically-heated furnaces, only two operators and a working day of eight hours, in which double the number of blades could be hardened. The practice was standardised, so that 70 lb. of blades were dipped at a time for a definite period into a salt bath maintained at its proper temperature by electrical heating apparatus and pyrometers. Contrast with that the manufacturer of small steel articles, who works up many thousands of pounds of raw material each year, hardening them all by hand methods, and believing them to constitute a valuable trade secret, whereas the actual result is a product very costly to make and variable in characteristics.

A Valuable Aid.

The treatment of sewage presents a complex problem, but one which can be overcome. It is contended by some that the separation of fats from sewage cannot be carried out profitably, but this has been successfully accomplished by means of new mechanical thickeners. The mechanical thickener is a valuable aid in preventing industrial waste. It provides a treatment tank at the same time and operates the discharge of thick sludge at one point and a clear liquid at another. Many materials filtered with difficulty before thickening may be filtered rapidly and economically afterwards. A factory in this country uses a continuous process in which, after filter pressing, the press cake is dried and extracted with benzine to effect the largest possible recovery. During one week of 168 working hours, 80 tons of sewage sludge cake containing 15 per cent moisture and 25 per cent grease were treated, resulting in 65 tons of residue suitable for fertiliser, and experience shows that such plants, under scientific control and careful management, can become profitable undertakings.

One of the greatest sources of waste lies in fuel consumption. Certain works, such as gasworks, smelting works, forges, rolling mills, etc., consume far more fuel for heating purposes than for power. In these works much waste escapes up the chimney of the heating furnaces, which might be saved by passing the waste gases through boilers. Very often this plan is carried out, but it is attended with inconveniences, even dangers, and each case must therefore be treated on its merits.

GAS AND FUEL ANALYSIS FOR ENGINEERS. By Augustus H. Gill, S.B., Ph.D. London: Chapman and Hall, 11, Henrietta Street, Covent Garden, W.C.2. 6s. nett.

An eighth edition argues a book of practical value. The work has apparently been little altered since its first edition. No doubt it has been brought up to date and new practice included. The layout of the book is one obviously designed to act as a text-book for students. It certainly approaches in its chapters the quality and quantity of a series of lectures, but loses nothing thereby. In fact, the book is one that can be read with advantage by many who do not call themselves engineers, but are concerned in the production and use of power. The illustrations are clear, and have a practical value.

PRODUCER GAS FOR MOTOR VEHICLES.

By D. J. Smith.

(*Continued from page 229.*)

The Performance of a Petrol Vehicle on Producer Gas.

The use of producer gas derived from anthracite or coke on a petrol vehicle without any alteration in the engine or the gear ratio could hardly be expected to give satisfactory results, yet the following details show that it is possible for the vehicle to put up quite a good performance, and the saving in cost of fuel would more than counterbalance any drawbacks due to the use of producer gas.

The vehicle in question was fitted with a 4-cylinder engine 4½ in. diameter by 5 in. stroke, and, owing either to wear or design, the gauge compression pressure was only 65 lb. per square inch. Four speeds were fitted and the final drive was by worm, making any alteration in the gear ratio impossible. The weight of the vehicle fitted for petrol was 3 tons 12 cwt. 3 qrs. The carburettor and its connections were removed and the producer plant fitted, bringing the weight up to 3 tons 15 cwt. The vehicle had been "cast" or discarded for service, and was in need of thorough overhaul, but no work of any sort, apart from the fitting of the producer, was carried out.

The petrol consumption had been officially checked for over 1,000 miles while the vehicle was running on its ordinary work and found to be 4·7 miles per gallon. As it is necessary to deal with fuel by weight, it is assumed that a gallon of petrol weighs 8 lb., and this corresponds to 1·7 lb. per mile. The rated load of the vehicle was two tons, giving a net load consumption of 0·85 lb. of petrol per ton-mile, and 0·29 lb. per gross ton-mile. At the period when these tests were carried out, May, 1918, petrol was 3s. 4d. per gallon and anthracite 40s. per ton.

Table II. gives the figures of performance on a run of 50 miles:—

Table II.

Tare	3 tons 15 cwt.
Loaded weight	5 tons 4 cwt.
Mileage	50
Weight of coal consumed	104 lb.
Consumption per vehicle-mile	2·08 lb.
Consumption per gross ton-mile	0·4 lb.
Consumption per net ton-mile	1·43 lb.

On this particular vehicle, both fuels were being used uneconomically, but the relatively high consumption of coal compared to petrol is due to the unsuitability of the engine owing to low compression for use with producer gas. In the matter of cost, Table III., the figures are remarkable, in spite of this serious handicap.

Table III.

Cost per vehicle-mile, petrol	8·5d.
Cost per vehicle-mile, coal	0·566d.
Cost per gross ton-mile, petrol	1·450d.
Cost per gross ton-mile, coal	0·0856d.
Cost per 100 miles, petrol	£3 10s. 10d.
Cost per 100 miles, coal	4s. 8½d.

The saving is so great that there is no need to strive after great economy in the use of the coal, and no firm running petrol-driven vehicles could compete in a carrying business with a firm using producer gas. The above figures, however, can be taken as a basis of comparison with any petrol-driven vehicle when converted to use producer gas.

The consumption of water could not be closely checked, as with this plant the feed pump was driven by the same crank as the ash discharge, and if the stroke of the pump was diminished to give the right quantity of water, there was no discharge of ash. This has been remedied on the plant shown in Figs. 3 and 4, a test of which over two miles with the pump out of action and the water measured into the vaporiser, gave a consumption of 10 oz. per mile, or 0·3 lb per pound of fuel. This is, however, too little for average working and did not allow for any loss due to rolling, undue consumption on hills, etc., and the figure for water consumption should be taken at 0·5 lb. per pound of fuel as a maximum.

Nearly a year later, this vehicle, then in a worn-out condition, was put through another series of trials, and then only consumed an average of 3·2 lb. per vehicle-mile. Owing to the bad condition of the fire grate, due to various fuel experiments, a large portion of the fuel passed through unburned. This and the generally bad quality of the fuel provided accounted for most of the extra con

sumption. The results obtained on petrol vehicles are sufficiently good to encourage the production of a vehicle designed for the use of this fuel, which removes one of the greatest handicaps to the development of road transport—dear fuel.

The Field of Application.

The field of application of producer gas to vehicle propulsion is very wide. The first and largest application will undoubtedly be to the heavier type of commercial vehicle. With light commercial vehicles and cars there may be some opening, but the author has never considered this seriously, as one of the chief advantages with these vehicles is rapid starting, and consequent usefulness for short journeys. A producer gas vehicle, using coal, cannot start from all cold in less than 14 to 15 minutes, and although it is possible to keep the fire alight for a week and get away at any time in five minutes, even this delay is serious, and was one of the chief reasons for the death of the steam pleasure car.

An attempt is now being made to fit a producer to a light car. The author is not very favourably impressed with this application, which will reduce the producer to practically model dimensions, but it is quite possible that there may be a demand for this fuel for cars, owing to the great saving in running cost possible by its use, and the fact that it would enable vehicles to be run in places where liquid fuel is difficult to obtain.

By running the heavy vehicles, which have a very short mileage per gallon of petrol, on producer gas, it would release more petrol for light vehicles, and might have some effect on the price.

For agricultural tractors, producer gas should have a wide scope. The cost of liquid fuel is a very serious consideration in agricultural work, and has undoubtedly restricted the use of internal-combustion tractors and ploughs up to the present. In many districts, local fuel could be used in the producers, giving power at practically no cost, and this should be reflected in the price of food and living generally.

For road rollers, heavy road tractors, and other uses where a considerable amount of power is required, and it has been too costly to use petrol, internal-combustion engines can now be used. For most purposes where internal-combustion engines, using liquid fuel, are in use on any form of vehicle, producer gas could be substituted without difficulty and with a great saving in fuel cost.

Effects of Producer Gas Used in a Petrol Engine.

As a considerable amount of use may be made of producer gas in engines designed for petrol, some notes on the effect of this fuel on such engines may be of interest. In the first place, it was found that by using producer gas, lubrication troubles and troubles with carbon deposit caused by the present heavy petrol were greatly relieved. Producer gas has no diluent effect on lubricating oil, and thinning out of the oil, with its consequent troubles, does not occur. The pistons also remain practically free from deposit, and it would only be necessary to decarbonise these at very long intervals, if at all.

With some engines with enclosed valves, trouble is likely to arise from the lubricating oil charring or carbonising on the valve stems when producer gas is used. With petrol, this does not often happen, as the petrol vapour thins out the oil and prevents it caking. Even some petrol engines, however, are subject to this trouble, and this would be aggravated if producer gas were used.

Generally speaking, brass or gunmetal should not be used in contact with the gas, though the author has not found any ill-effects on the induction pipes, etc. Knocking or "pinking" never occurs with producer gas, even if the speed of the engine is greatly reduced by the load, and with the ignition fully advanced, and it is very surprising how the engine will continue to pull up an incline without changing gear, until it is just turning over. It is not advisable to do this, as the power of the engine is proportionate to its speed, but it is an interesting point as showing the flexibility of the producer. The use of unwashed gas has not been found to cause any deleterious effects on the metal of cylinders, valves, or pistons, which remain clean.

Some difficulty in starting up after a long run was experienced when using sparking plugs of the type having a stout central electrode and a thin wire electrode bent over from the shell. Examination showed that the heat had caused the thin wire electrode to drop away from the central electrode, and if this was bent back again, the plug would function satisfactorily until the engine was again stopped and allowed to get cold. This would seem to indicate that although the total heat evolved per charge with producer gas is less than that of petrol, the flame temperature is higher, as this trouble did not arise with petrol. The substitution for this type of plug of the type in which the central electrode is surrounded by a corrugated edge disc, quite removed the trouble. The sparking plugs keep very clean indeed on producer gas. No serious trouble is, therefore, to be anticipated in the use of producer gas in an engine designed for petrol, apart from that of loss of power which is dealt with elsewhere.

Upkeep.

The upkeep cost of the producer is a point which is frequently raised by those who are considering its application to motor vehicles. The working parts or parts liable to need renewal are the firebars and the refractory lining. The mechanically operated parts of the producer, owing to the very low speed, will seldom require attention during the life of the vehicle, but the lining and firebars require periodical renewal. The cost of fitting a new lining is made up chiefly of the labour involved in the taking down and re-erection of the producer. A lining should run approximately 10,000 miles, which can be taken as a year's work for the majority of lorries, and a set of firebars should have the same life. The cost of fitting the new lining would be about £2, including the lining, while the cost of the new bars per set would be approximately 15s., though a whole set is seldom required, the centre bars going first. As the bars can be fitted without dismantling the producer, little labour cost is involved. The upkeep cost is, therefore, very low and presents no obstacle to the adoption of producer gas.

Exhaust Gas Analysis.

Assuming the possibility of large numbers of vehicles running on producer gas being used in congested traffic areas, it was thought advisable to examine the exhaust gases emitted by such a vehicle while running in dense traffic. For this purpose, an opening was made in the exhaust manifold, and from this, samples of the exhaust gases were taken while the vehicle was running at different speeds and on different gears. The route chosen was a typical London omnibus route and included congested areas at the busiest hours. The analyses are given in Table IV., and it will be seen that no apprehension need be felt that any annoyance will arise from the use of producer gas on vehicles in towns, the results comparing very favourably with those from the exhaust of petrol-driven vehicles.

TABLE IV.

Description of Test.		Analysis.		
		Carbon Di-oxide. CO_2.	Free Oxygen. O.	Carbon Mon-oxide CO.
Engine idling.	400 r.p.m.	14·1	3·4	Nil
4 m.p.h.	800 „	14·0	1·6	Nil
6 „	700 „	7·0	1·8	Nil
8 „	700 „	5·0	·6	Nil
9 „	800 „	5·1	3·1	Nil
8 „	600 „	14·5	1·3	Nil
6 „	500 „	6·2	Nil	1·9
5 „	800 „	9·4	Nil	2·0
5 „	600 „	7·0	3·9	Nil
Engine idling		11·1	4·4	Nil

It should be noted that these tests were taken from an engine with a compression pressure of only 65 lb. by gauge, and thus not suitable for the economical use of producer gas. The range of ignition advance was also insufficient.

(To be continued.)

PIECE-RATE PREMIUM AND BONUS. By J. E. Prosser. London: Williams and Norgate, 14, Henrietta Street, Covent Garden, W.C. 6s. nett.

An opportune book, and one worthy of close consideration by employer or operative. It does not set out to be propagandist in any direction, but clearly conveys information relative to the working of certain methods of payment. Particularly interesting at the moment is the chapter on "Profit-sharing." If, as is pointed out by many eminent business men who have adopted it, the men give of their brains as well as muscles, then, indeed, it is a valuable and far-reaching return.

MARKETS FOR BRITISH GOODS.

In a recent issue we gave a list of European markets in which, owing to the long months of war, there is now a pressing demand for goods of all kinds. That article was so much appreciated by our readers that we have now collected further particulars from other European and overseas markets.

Italy.—Mr. F. Orsi, 10, Via Cappellini, Milan, wishes to place some orders for paints, dyes, and colours, and would be glad to receive price lists and particulars. Sulphate of copper is required also in Italy. Mr. Alfredo Susini, of 82, Via Buontalenti, Leghorn, has several orders to place for oil motors for agricultural purposes, and would be glad to receive prices and catalogues. Varnishes are also in strong demand.

Belgium.—Firms in Antwerp are now enquiring for about 300 electro motors of from 1 to 15 H.P. Locks, keys, tools, ironmongery, heavy chemicals, starch, dextrine, grinding and mixing machines for paints, oils for paints, linseed oil, tobacco machines, cigarette machines, hosiery, workmen's clothing, cloth, rust preventers, lead and tin are also needed in considerable quantities in this country.

Spain.—This country has a good many buyers of motor cars, motor lorries, motor cycles, and chemical preparations. In the district of Valencia there is an especially pressing demand for ironmongery, motor cars, and mechanical appliances for household use.

Norway.—Inquiries have been received from this country for tubes, pipes, tools, and electrical articles.

Bulgaria.—Orders are waiting to be placed from this country for machines of all kinds, but more especially agricultural machinery, ironmongery, material for manufacturing hats, ironware, copper plates, machines, and materials for the manufacture of soap, articles for farm use, colours, paints, and machinery for printers and bookbinders.

Rumania.—Good orders can be secured for band and other saws, lathes, planing machines, shaping machines, carpenters' tools, and machines for joinery, etc.

Dutch East Indies.—There is a good inquiry here for iron and steel, and products for pharmaceutical purposes.

South Africa requires chemicals for mining purposes, and dyes of all kinds.

Japan is a buyer of tool steel and machinery.

Guatemala is in urgent need of ironmongery and machinery. The stocks of these goods are practically exhausted.

Brazil.—It is now proposed to open an automatic telephone service at Porto Alegre. As soon as it is completed the smaller towns of this republic are also to be fitted with telephone services. The three largest cities, namely, Porto Alegre, Pelotas, and Rio Grande do Sul, are fitted with electrical switchboards on the Siemens and Halske system, which are now practically worn out. Sao Paulo requires ironmongery, woollen goods, and cement. Catalogues are required at Porto Alegre for coal-mining machinery of all kinds, drills, briquette-making machinery, price lists of which should be sent to Snr. Dr. Ildefonso Soares Pinto, D.D., Secretario de Estado dos Negocios das Obras Publicas, Porto Alegre, Rio Grand do Sul, Brazil.

ADVERTISING IN THE ENGINEERING INDUSTRIES.*

Advertising is Selling.

Advertising in industry is selling. No matter how subtle the advertising means the object in view is always the same, namely, the disposal of some commodity. In addition to the personal factor referred to above, advertising can be by one or more of the following methods: (1) circular letter, (2) bound catalogue or bulletin, (3) posters, enamelled plates, showcards, or show cases, (4) general newspaper or trade paper publicity.

Engineering advertising has not yet received that serious consideration which its relation to sales would justify. The advertisements of engineering products of the last quarter of a century suggest that publicity has not been regarded by the manufacturer as an investment ensuring a definite return. The business pages of early copies of the pioneer industrial journals give the impression that the "copy" was prepared by the secretary, the chief clerk or the head of the stationery department! Perhaps the managing director took sufficient interest when the proof was submitted to have the name of the company put in heavier block type! Some advertisements were published without change of copy for years. It was not unknown for a publisher to ask an advertiser of this class to replace a badly worn block with a new one. Such requests would remind the advertiser of the existence of his announcement, and he would indignantly reply cancelling the advertisement! Naturally, the publisher "got wise" to this eventuality, and rather than lose the order he replaced worn blocks at his own expense! Happily this condition of things is changing. Indeed, during the past five years, especially, engineering advertising has improved almost beyond recognition.

Publicity Engineers.

The necessity for the head of the publicity department of an engineering firm being himself an engineer is not yet recognised as it should be. There are men who combine engineering experience and advertising ability. The publicity work is immensely fascinating and offers scope for talents not unknown even amongst such practical people as engineers. At present the bulk of the engineering advertising work is done by men having a knowledge of types, layout and printing paraphernalia. The technical portion of their work is usually supervised by the engineering staff, who have to keep an eye on the advertisements. The writer is of opinion that engineering industries should take steps to encourage the brighter members of their selling staffs to qualify for the post of advertising manager. If it is agreed that advertising is selling, and that the most suitable salesmen of engineering products are engineers, it follows that

* Paper read before the Birmingham Electric Club by Mr. W. E. Warrilow, A.M.I.E.E., March 13th, 1920.

sales' engineers will also make good advertising men. It is possible to point to successful advertising men in engineering who are not engineers; on the other hand, the writer knows of several engineers who have started in business as service agents, and obtain publicity business from electrical and mechanical engineers because of their knowledge of engineering. The failure of general advertising agents to handle this class of advertising is fairly well known, and is simply attributable to disregard of its possibilities.

In the early days the engineer would have looked with disfavour upon the idea of training himself to sell the products of the works in which he served his time. He felt that he was taking up the business of engineering, and not that of a commercial traveller. But experience has shown that "sales engineering" is not only a highly interesting business, but also an honourable and profitable one. It is no longer derogatory for an engineer to go out and sell. He can employ his engineering experience and knowledge to great advantage in this capacity, particularly if he has a natural aptitude for the work. His special knowledge makes him a great acquisition. The writer submits that it is from this class of man that the "publicity engineer" is to be drawn.

Two Classes of Engineering Publicity.

The engineering industry differs from many others in that a large proportion of its products is sold without advertising of any kind. Heavy plant and machinery, generating plant equipment, and engineering material of a similar kind are sold to the specification of a consulting engineer and by public tender. Similarly, quotations for contracts for yearly stores are made in response to the advertisements of public authorities, Government departments, and similar institutions. Obviously such business cannot be obtained through the medium of advertising. Manufacturers engaged exclusively in this class of trade resort to what may be termed "goodwill" advertising. Advertisements are inserted in the trade journals, and the copy, which is seldom changed, usually gives the name and address of the firm, perhaps a view of the factory, and a list of its principal products; also a line to the effect that *enquiries* are invited. The latter are received and dealt with by the sales manager, and in such cases there is no recognised advertising department. There is another class of publicity which is now receiving better attention in the engineering world, and this makes a direct appeal for orders for the particular article advertised. The copy for this style of advertisement requires to be prepared with care, and must be written with a definite sales purpose. Instances can be quoted of engineering firms who have adopted this form of publicity and have been agreeably surprised with the results. In such cases the advertising department should be in the hands of a sales engineer. There is, of course, a marked difference between the foregoing two classes of publicity. In the first case the manufacturer has no definite article ready for delivery, but invites enquiries, and is prepared to quote either for standard lines or some special requirement. In the second case, the manufacturer has, or should have, the advertised articles ready for delivery, and when this is so and the campaign is efficiently conducted with forcefully written copy, the results are encouraging, and give the manufacturer a good opinion of advertising generally.

The Complete Block Copy.

One of the best means of disposing of the mass products of the factory is to plan an advertising campaign as soon as the production is well on the way. The article itself being standardised copy, can be prepared in advance. Undoubtedly, the best method of drawing up the copy is to agree upon the designs of the various advertisements and make them up as complete blocks. Electros are then taken, and these are sent to the papers in which it has been decided to advertise. Each journal is instructed to insert the copy in accordance with programme and return the electros at intervals—say, every three months. The embodiment of the copy in a complete block gives the advertiser the advantage of selecting just what style of type he prefers.

The printers of trade journals have usually not a wide selection of types, and delay is frequently caused by arguments regarding setting when the proofs are submitted.

Further, an enormous amount of time is saved when the copy is sent out as a complete block, because no proofs are needed, and the publishers of the trade papers do not have to keep worrying. The treatment of advertisement copy in this way is considered to be only possible with a standard product. It presents possibilities to advertisers handling certain lines of goods which vary only a little in the matter of design. In such cases the best plan to follow is to draft up a series of advertisements to cover, say, three months, have electros made of these sent to the papers, and during the time of their appearance prepare the matter in the same way for the next three months. My experience as an advertising manager is that it is comparatively easy to get orders and appallingly difficult to extract the copy. If the printing and paper situation becomes more acute than it is to-day, publishers will have to charge advertisers for corrections and delays in connection with the handling of their copy. Perhaps when this happens we shall see more complete electros supplied for advertisements!

Service Agencies.

Much of the foregoing applies to firms in a big way of business, who can run their own advertising departments. These are, however, many smaller undertakings who desire to advertise but cannot support a separate department. It is interesting to note that during the past five years service agents have become available, and some specially cater for engineering business. Such agencies can point to the successful handling of many advertising accounts. It is true there have been failures, but in the majority of cases the publicity of the customer has been so handled as to increase his business solely through the medium of trade press, catalogue, and circular letter advertising. The writer's experience as a newspaper man is that such agencies can render valuable service to firms whose publicity appropriation is in the aggregate only a moderate sum. It is not possible for manufacturers with a small turnover to engage expensive engineering advertising men as permanent members of their staff. It is sometimes argued that the service agent cannot possibly appreciate the details of every client's business. This may be true to some extent, but the relations between the

client and the service agent would be greatly improved if the agent be given facilities to look round the client's works and know something of the inner workings of his business. In many cases experience with service agents has proved that sound advice has been given to the client regarding the choice of his advertising media and the direction of his appeal for business into the proper markets.

(To be continued.)

AIR SUPPLY TO FURNACES.*

By G. A. Rosetti.

In the design of a boiler house installation, a question which presents itself almost at the beginning of the work is "What amount of air supply must I provide for?"

The answer to this question must be settled, at least approximately, and either by calculation or by guesswork, whether the draught is to be produced by a chimney or by a fan or compressor. If mechanical draught is to be adopted, the size of the fan, the power to be provided for driving it, and the design of the air ducts, are all dependent upon the amount of air which is to be dealt with.

In general, in dealing with problems of boiler plant, the basis upon which all other figures depend is the output required, which is usually specified as so many pounds of water to be evaporated per hour, as from and at 212 deg. Fah. Knowing this figure, the engineer proceeds to estimate the weight of coal needed per hour, deriving this figure in its turn from the specified or assumed calorific value of the fuel, and the efficiency likely to be obtained. Then a figure is taken (usually a very rough estimate) for the pounds of air needed per pound of coal, and thus the total air supply necessary is worked out.

This method may appear to be the most natural route to get at the air supply from the specified output. But it involves certain disadvantages. The calorific value of the coal is not always known with accuracy, and even if the use of a particular coal is contemplated, of which perhaps a sample can be obtained, it may very well be unavoidable later on to use some coal from a different source, and the question should be faced at the beginning as to what margin of variation should be allowed in order to provide for any such change.

It is therefore interesting to consider whether the answer to this air supply question cannot be reached by the examination of other factors, independent, as far as possible, of the nature and quality of the particular fuel to be burnt.

In comparing the action on the grate surface when burning two coals of widely different quality, it is clear that a greater weight of the poorer fuel must be burnt in order to produce the same output; but it is also the case that the better fuel needs a larger weight of oxygen per pound for complete combustion. It is obvious that this is so if the difference is due to the poor fuel containing a larger percentage of ash or other matter which cannot be burnt at all. Low-grade fuels, also, contain, in general, a fairly high amount of oxygen in the chemical composition of the combustible matter. This oxygen reduces the calorific value, and it also reduces the amount of oxygen to be supplied to the furnace for combustion.

We are thus led to consider whether it is possible to obtain a figure which shall represent, with reasonable accuracy, the calorific value to be got from a fuel per pound of oxygen needed for combustion, instead of (as it is commonly expressed) per pound of fuel burnt.

The heat produced by the burning of fuel is derived almost wholly from the combustion of the carbon and of the hydrogen which it contains. If we are dealing with a fuel containing (apart from inert matters) C per cent of carbon and H per cent of available hydrogen (that is, hydrogen minus one-eighth of the oxygen) the calorific value of 100 lb. of this fuel will be, according to Dulong's formula, which gives results in fairly close agreement with experiment, 14,600 C + 52,000 H. B.Th.U. The figure 52,000 is used as excluding the latent heat in the water vapour produced by the burning of the hydrogen. These 100 lb. of fuel will contain C pounds of carbon and H pounds of available hydrogen, and will thus need for combustion

$$\frac{8}{3}C + 8\,H \text{ pounds of oxygen.}$$

The ratio of these figures gives the heat produced per pound of oxygen used

$$= \frac{14{,}600\,C + 52{,}000\,H}{\frac{8}{3}C + 8\,H}\ \text{B.Th.U.}$$

which may be reduced to the more simple equivalent form,

$$\frac{5{,}475\,C + 19{,}500\,H}{C + 3\,H}\ \text{B.Th.U.}$$

per pound of oxygen. In order further to simplify this expression, let us assume that the percentage of carbon is equal to n times the percentage of available hydrogen, that is, in symbols, $C = n\,H$. The formula for the heat produced per pound of oxygen then becomes

$$\frac{5{,}475\,n + 19{,}500}{n+3}\ \text{B.Th.U.,}$$

which may be written as

$$5{,}475 + \frac{3{,}075}{n+3}\ \text{B.Th.U.}$$

Thus, if the value of n is known, the heat per pound of oxygen may be obtained. In the various types of coals used for power purposes, the value of n is confined within a comparatively narrow range, the limits of 18 to 24 including nearly all fuels in use from anthracites to lignitious fuels. In the lignites the value of n tends to rise, on account of the increase in the amount of oxygen contained in the fuel. The above formula shows that as n increases in value the heat produced per pound of oxygen diminishes, though only slowly. Taking the extreme values mentioned the formula gives the following results:—

$n = 18$; Heat per pound of oxygen = 5,621 B.Th.U.
$n = 24$; Heat per pound of oxygen = 5,589 B.Th.U.

Since these figures differ by less than one per cent, it will be quite sufficient, for practical purposes, to consider the value as a constant, and to write: Heat per pound of oxygen = 5,600 B.Th.U.

* "Cheap Steam."

The figure thus obtained may now be used for the solution of the air supply problem. To evaporate one pound of water, as from and at 212 deg. Fah., requires 969·7 B.Th.U.; air contains 0·23 of its weight of oxygen. Thus each evaporation unit will need a theoretical air supply of

$$\frac{969{\cdot}7}{5{,}600 \times 0{\cdot}23} \text{ pounds,}$$

or 0·753 lb. This represents the air actually used, on the assumption that 100 per cent efficiency is obtained. In practice the figure must be increased, to allow for the excess air necessary, since it is not possible to use up the whole of the oxygen sent into the furnace. A further increase is necessary because the efficiency will not reach 100 per cent. The excess air admitted to the furnace is a very variable quantity; the more perfect the type and control of the furnace, the smaller will it be. Also, as a rule, the more anthracitic fuels need a less excess of air for satisfactory combustion than those with a larger amount of volatile matter. The actual excess admitted in any given case may be approximately estimated from the determination of the percentage of carbon dioxide in the gases of combustion. If this percentage = A, then the fraction 21/A gives with fair accuracy the ratio of air actually admitted to that theoretically needed. If this ratio be indicated by R, it may be said that in practice R will never be less than 1·5, and may rise as high as 3, or even higher, when burning certain types of fuel under unfavourable conditions. In estimating the air supply to be provided, it is reasonable to assume R = 2; a value which ought not to be reached in good mechanical furnace practice, but which gives a certain margin of safety for the possible occurrence of unfavourable conditions.

The fact that the efficiency will not reach 100 per cent means that a larger weight of fuel must be burned than is theoretically needed to give the specified output. Thus the air supply also must be increased in the same ratio, that is, in the ratio of 100 to E, where E is the efficiency actually obtained. In practice E may be taken as 70 per cent. It should not fall much lower, and though higher values are not infrequently shown on tests, it is yet safer to take the value no higher as a basis for the estimate of the supply.

We are thus led to the following very simple formula for the air supply to be allowed in any particular case—

Let S = air to be supplied, in pounds per hour;
W = evaporation units per hour, or pounds of water evaporated, as from and at 212 deg. Fah., per hour;

then $S = W \times 75{\cdot}3 \times R/E$,

if, as suggested above, the following values are assumed— $R = 2$, $E = 70$

then $S = 2{\cdot}15 \times W$.

In specifying the size of a fan it is usual to give the air supply in cubic feet per minute. To get this figure, the value of S determined as shown must be divided by 60 and the quotient multiplied by the cubic feet per pound of air. This value depends on the temperature; at 60 deg. Fah. it is 13·09 cubic feet per pound, and it increases by very nearly 1 cubic foot per pound for each 40 deg. Fah. increase of temperature.

The short table given below is for the purpose of facilitating the application of this method of calculating the air supply in cases when it is needed to have this figure as so many cubic feet of air per minute, when the boiler output is specified in evaporation units per hour. The table gives three columns, headed respectively T, V, K. The meaning of these symbols is—

T = temperature of air in degrees F. In the table as given the temperature begins at 60 deg., and rises to 600 deg. by intervals of 50.

V = volume of air, in cubic feet per pound, at temperature T.

K = coefficient to give air supply required, in cubic feet per minute, corresponding to boiler output specified in evaporation units per hour. K is obtained from the formula $K = V \times 2{\cdot}15/60 = V \times {\cdot}03583$.

T	V	K
60	13·09	0·469
100	14·09	0·505
150	15·34	0·550
200	16·59	0·594
250	17·84	0·639
300	19·09	0·684
350	20·34	0·729
400	21·59	0·774
450	22·84	0·818
500	24·09	0·863
550	25·34	0·908
600	26·59	0·953

The following example will illustrate the application of this method of calculation. Assume that a pair of boilers are to be installed, each to have an output of 40,000 evaporation units per hour. What air-supply must be given, and what fan capacity is needed? In this case, taking the pair of boilers, we have W = 80,000. Thus, taking R = 2 and E = 70, we get $S = 2{\cdot}15 \times 80{,}000 = 172{,}000$ lb. per hour, which is the amount of air needed. The volume to be dealt with by the fan is obtained by the coefficient K. Thus, if we are dealing with air at normal temperature, say 60 deg. Fah., K = 0·469, and the volume to be dealt with by the fan is $80{,}000 \times K = 37{,}500$ cubic feet per minute. If, however, the fan is to pass the hot flue gases, say at 500 deg. Fah., then K = 0·863, and the volume becomes 69,000 cubic per minute.

In a case where R and E are to be taken at other values than 2 and 70, then both the weight and the volume of the air supply will be changed. In this case the weight may be calculated by the formula given above—$S = W \times 75{\cdot}3 \times R/E$, which applies to all values of these factors. The volume, in cubic feet per minute, is then got by multiplying S by V/60, where V is taken from the table corresponding to the temperature. Or, alternatively, the values of S and of the volume per minute may be got from the formula: $S = 2{\cdot}15 \times W$; Volume $= K \times W$, and then these values are multiplied by the value of 35R/E, to give the figures corresponding to other values of R and of E. Thus, if, in the example given above, it were desired to assume R = 1·5 and E = 75, then the values obtained for the air supply would be multiplied by $35 \times 1{\cdot}5/75$ or by 0·7. Hence we should get—

$S = 172{,}000 \times 0{\cdot}7 = 120{,}400$ lb. per hour; at 60 deg., volume $= 37{,}500 \times 0{\cdot}7 = 26{,}250$ cubic feet per minute; at 500 deg., volume $= 69{,}000 \times 0{\cdot}7 = 48{,}300$ cubic feet per minute.

Trade Items, Notes, &c.

GAS FROM WASTE MATERIALS.

Due to the scarcity and consequent dearness of gas in Germany, Dr. A. Kühn, Councillor of Commerce of Munich, has called attention to the tests and results obtained therefore, which he has secured (already ten years ago) by treating the coarser portions of domestic refuse by distillation. At that time he had the organic substances of vegetable and animal origin (paper, rags, wood, bones, etc.) contained in domestic refuse sorted out and treated by distillation, without any further preliminary preparation whatsoever, at the experimental laboratories of the Cologne Gasworks at Niedermending. Instead of coal the retorts were charged with the refuse. The result was that the town of Niedermending for a couple of days used this "refuse gas" for lighting purposes without noticing any difference at all in the service; in fact, not one single complaint was received by the company as to poor lighting or heating power of the gas supplied. The expert opinion of Dr. Witzeck, manager of chemical laboratory of the Cologne Gasworks at the time, was that the new process, even in normal times, would give excellent economic results, particularly if special retorts were used for the purpose. As, under present conditions, an excellent gas could also be obtained, the question is being taken up again.

SPITZBERG AS A METALLURGICAL COUNTRY.

For the last fiscal year ending June 30th, 1919, the production of a colliery at Spitzberg is said to have amounted to 50,326 tons, which was purchased by the Norwegian Railway Companies or Norwegian Shipping Companies. It is now proposed to establish foundries and other metallurgical establishments close to the coal mines. The Polar explorer, Wilhjainur Stefansson has declared that there is no reason why foundries should not be opened at Spitzberg, the climate of which is far less severe than that of Winnipeg and other prosperous Canadian centres. The production can be maintained throughout the whole year. The argument deduced from the Polarnight against this project is absolutely valueless and will not hold water, because, on the one hand, it is lack of labour and lack of distraction which creates monotony in the arctic regions, whilst, on the other hand, more than enough labour and amusements will be provided for everybody in this Northern metallurgical centre when once created. On the other hand there is an unlimited supply of motor power, thanks to the large amount of coal available, and there is therefore quite sufficient light to supply the foundries during the whole of the long months of darkness.

THE KING'S NATIONAL ROLL. The first edition of the King's National Roll, which is now in circulation, contains nearly 10,000 names of patriotic employers who had, up to the end of 1919, given the necessary undertaking to employ an agreed percentage of ex-Service men on their staffs. Copies of the book, which consists of over 300 pages, are to be placed in all the Employment Exchanges throughout the country, with trade unions, employers' federations, ex-Service men's organisations, free libraries, and other public buildings, while every employer whose offer to embrace the scheme has been accepted will also receive a copy. His Majesty the King and Queen Alexandra stand at the head of the list in the first edition, and the roll, for purposes of easy reference, has been arranged in alphabetical order by counties. Since the first edition went to press the number of employers qualifying for the use of the "Seal of Honour" has been increased by over 2,000, and these, with the subsequent additions to the roll, will appear in the future editions. While it is gratifying to know that the number of employers who are willing to employ disabled ex-Service men is growing, it must not be forgotten that the supply of disabled men is, unhappily, by no means exhausted. There are still in the hospitals some thousands of men who were wounded in the war, all of whom will have to be found positions in civilian life again as soon as their discharge from hospital permits of them taking up work for which they are fitted. Every employer of labour, large and small alike, can help in absorbing these men back into industry. All than an employer has to do is to sign an undertaking that his staff shall include a percentage of disabled men, the percentage being agreed upon between him and the local Employment Committee at the nearest Employment Exchange. If the employer is willing to give the undertaking, but has difficulty in finding men to enable him to qualify for the insertion of his name on the National Roll, the local Employment Committee and the officials of the local Employment Exchanges will do their best to obtain the necessary number of men required. The majority of the employers whose names appear in the first edition of the National Roll have been asked their opinions with regard to the employment of disabled men, and in almost every case the reply which has been forthcoming has paid a tribute, not only to their eagerness to work, but has expressed satisfaction with regard to their efficiency as well.

The Swedish Board of Trade, in reply to a Government inquiry regarding the import of fuel oils and the regulation of the market for sulphite spirit, has recommended the purchase of foreign oil wells, the procuring of tank steamers, the erection of oil refineries in Sweden, and the formation of independent Swedish enterprises for wholesale trade in and distribution of oils and oil products. Fifty thousand tons of oils are considered sufficient to cover Sweden's annual requirements, and for this 12,000 tons deadweight would be needed for the transport. The building of two tank steamers is suggested at a cost of about 10,800,000 kroner. This should be left to private enterprise, with grants from Parliament. For this purpose the Board of Trade propose that the Riksdag should be asked for a grant of 8,000,000 kroner this year. In this connection a Swedish aviator, O. Dahlbeck, has written in the *Stockholm Dagdlad*, calling attention to the new American fuel oil "Alcogas," which he says has been used by the American postal authorities for their aeroplanes on the Washington–New York route. He recommends that attempts should be made in Sweden to produce a similar fuel oil from sulphite spirit.

A party of the London graduates of the Institution of Automobile Engineers visited the National Physical Laboratory at Teddington on Saturday, March 20th. The following is a brief summary of the incidents which were of greatest interest: The party inspected the wind channels which are utilised for calculating the lifting power and wind resistance of various designs of aircraft models at different velocities, thereby obtaining valuable data. The Metallurgical Department was then entered, where some very fine specimens of aluminium alloys, castings, rolled and drawn sections and sheets were exhibited. An inspection was then made of an instrument, designed at the laboratory, for showing and recording the heating and cooling curves of metals. From this department the party was taken to the William Froude tank, where at present models of cargo vessels are undergoing tests. The visit concluded with an inspection of apparatus used in the checking of jigs and gauges, and the gauging of screw-threads. One method is to project the thread by light on to a reflector, which again reflects the magnified contour on to a small platform, where the shadow can be compared with an accurate profile cut in a tinplate.

Publications.

The new edition of that well-known annual **"The Practical Electrician's Pocket Book,"** has just been received from the publishers (S. Rentell and Co. Ltd., 36, Maiden Lane, London, W.C.2). As usual, it has been most carefully revised, with the assistance of many able coadjutors. The editor has done his best to bring it into line with the latest practice in most of the leading branches of electrical engineering. As a result of this revision, the book is no less than 40 pages larger than last year, and readers of this paper will no doubt find much to interest them in the new sections dealing with electrical welding, electrical furnaces (including the Wild-Barfield steel-hardening process), porcelain grip fuses, electricity meters, truck-type switchboards, as well as in many other sections. We notice with pleasure that the wiring tables have been arranged in conformity with the new specifications of the Engineering Standards Committee, and, at the same time, to facilitate reference, the old tables are retained. Further, the chapter on illumination has been rewritten by a well-known expert, and the central station tables, which are a useful feature, have been recast and enlarged. Altogether, the book is well worth the modest 2s. 6d. at which it is published.

FACTORY AND WORKSHOP.

CERTIFYING SURGEONS' FEES.

ORDER DATED 9TH MARCH, 1920, MADE BY THE SECRETARY OF STATE, UNDER SECTION 124 OF THE FACTORY AND WORKSHOP ACT, 1901 (1 EDW. 7, C. 22), IN REGARD TO FEES FOR EXAMINATION FOR CERTIFICATES OF FITNESS.

In pursuance of Section 124 of the Factory and Workshop Act, 1901, I hereby order that for the scale of fees set forth in Part I. of the Fifth Schedule to the Act there shall be substituted the following scale :—

When the examination is at the factory or workshop.	1s. for each person examined, with a minimum fee of 2s. 6d. for any one visit; and also, if the factory or workshop is more than one mile from surgeon's central point, 6d. for each complete half-mile over and above the mile.
When the examination is not at the factory or workshop, nut at the residence of the surgeon, or at some place appointed by the surgeon for the purpose, and that place, as well as the day and hour appointed for the purpose, has been published in the prescribed manner.	1s. for each person examined.

This Order shall come into force on the 22nd March, 1920.

E. SHORTT,
One of His Majesty's Principal Secretaries of State.

Whitehall, 9th March, 1920.

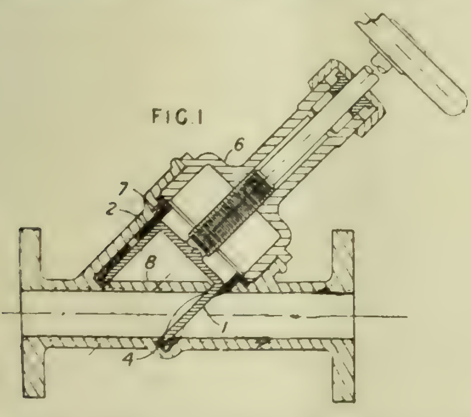
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

VALVES.

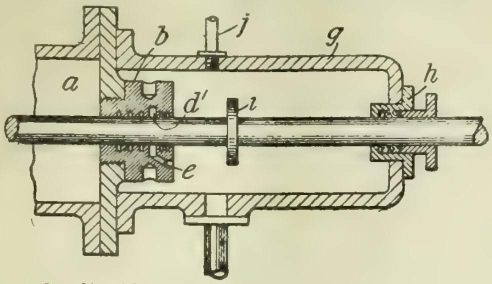
126,488.—D. ROSE, 81, Hewson Road, Lincoln.—May 21st, 1918.—A piston valve comprises a tubular member 1 adapted to work in a recess arranged at an angle to the main passage and has the end of the member 1 adapted to come into metal-to-metal contact with a seat 4 situated at the bottom of the recess. The seat may be formed on a separate member 2 held against rotation



by a key 7 and secured in position by the cover 6. Either the casing or seat is formed with a guide-member 8 extending above the valve seat and provided with a passage forming a continuation of the main passage. The main passage may be lined with an alloy consisting of 67 per cent nickel, 28 per cent copper, and 5 per cent other metals made direct from the ore without separating the constituent metals.

STUFFING-BOX SUBSTITUTES.

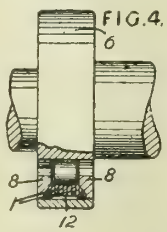
126,167. H. V. A. BRISCOE, 32, Blenheim Gardens, and F. W. BERK AND CO., 1, Fenchurch Avenue, both in London, and D. H. THOMAS, 56, Waun Road, Morriston, Glamorganshire.—May 15th, 1918.—A packing arrangement which is especially applicable for pumps for corrosive liquids consists of a grooved bush b enclosed in a chamber to which compressed air is admitted by a pipe j



to balance the liquid pressure in the pump cylinder a. The chamber g is attached to the cylinder cover an dits outer end is closed by a stuffing-box h. A collar i on the piston-rod prevents liquid from creeping along the rod, the chamber g being sufficiently long to permit reciprocation of the collar. One or more enlarged grooves $d1$ in the bush b collect leakage which is drained away by a passage e. According to the Provisional Specification, the bush b and the chamber a are made of gun-metal and the chamber a is preferably divided axially.

BEARINGS.

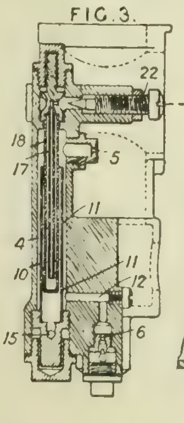
126,543.—A. H. HINDLE and S. W. SAVAGE, 49, King Street, A. E. DABBS, 19, Rowan Avenue, Whalley Range, and A. LIDDLE, 3, King's Road, Alexandra Road South, all in Manchester.—July 25th, 1918.—The outer race of a ball or roller bearing consists of a helical coil 1 supported at its ends only and free to yield at the central portion by the provision of a clearance 12 formed

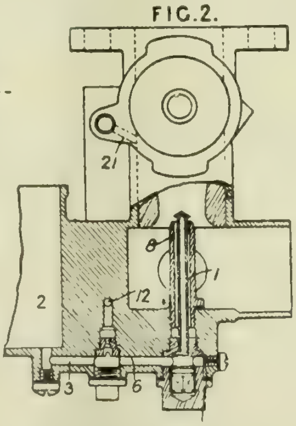


by recessing the coil or the housing 6. The ends of the coil rest on conical screwed rings 8 by which the tension may be adjusted. In a modification, the rings are omitted and the coil rests in a housing ring 6 formed with a shoulder at one side. The surfaces of adjacent coils may be concave and convex so as to inter-engage.

INTERNAL-COMBUSTION ENGINES.

126,535.—J. FAGARD, 30, Thomas Street, London.—July 6th, 1918.—An auxiliary nozzle surrounding the main nozzle and fed from a fuel well having a restricted opening to the atmosphere, is connected to a conduit having openings into the well at different heights, so that, as the engine suction increases, the fuel rises in the well above the openings and more fuel and a stronger mixture pass to the auxiliary nozzle. Alternatively, the auxiliary nozzle communicates directly with the well which is fed through openings at different heights in a conduit supplied from the float chamber. The main nozzle 1 communicates with



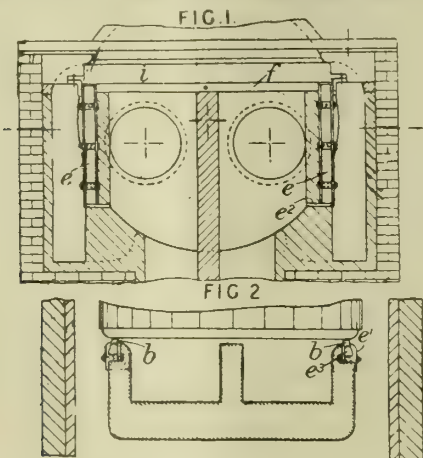


the float chamber 2 by a passage 3 having a restricted opening 6 into a passage 12 leading to a well 4. This well is open to the atmosphere through a restricted aperture 5 and contains a tube 10 open at the top and communicating through a passage 15 with the auxiliary nozzle 8. Holes 11, at different heights in the tube 10, permit the passage of fuel from the well 4 to the auxiliary nozzle. A pilot jet 21 is also fed from the well 4 by means of two concentric tubes 17, 18, the latter nearly closed

at the bottom. The air-supply to the pilot jet is regulated by a screw 22. For use on aeroplanes, the size o the aperture 5 of the well may be varied automatically or mechanically according to the altitude, in any manner. Specifications 103,627 and 105,309 are referred to.

STEAM-GENERATORS.

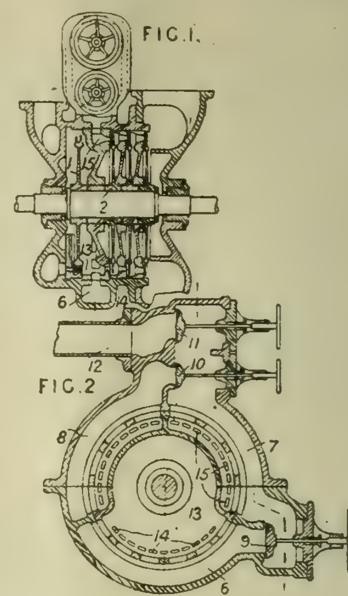
126,796.—T. HILL, the Springs, Parkhills Road, and H. G. INMAN, 8, Irwell Street, both in Bury, Lancashire.—May 16th, 1918.—An expansible joint between the rear end of a Lancashire or like boiler and the flue brickwork comprises vertical plates *b* fixed to the boiler end plate, and guides *e* in the side walls of the flues, the plates and the surfaces of the guides with which they engage



being inclined to the end-plate so as to allow for transverse as well as longitudinal expansion and contraction of the boiler. A guide consists of a vertical casting *e*1 with a bottom extension *e*2 built into the brickwork, and a plate *e*3 bolted to a central web on the casting. The top of the flue is closed by a bar *f* fixed at its centre and having rabbeted ends fitting in rabbets in the top of the plates *b*. The upper surface of the bar is inclined to engage with a correspondingly inclined surface on a ridge projecting from the under side of the flue-cover bearer *i*.

TURBINES.

126,622.—H. QUIBY, 19, Hardturnstrasse, Zurich, Switzerland.—May 3rd, 1919. Relates to means for regulating multi-stage turbines in the low-pressure stages of which steam from two different sources is used. The steam space of stage 2, which can receive steam from the preceding stage 1 through a space 13 or live steam through a pipe 12 and valve 11, is divided into three chambers 6, 7, 8 interconnected by valves 9, 10. For lowest speed, the valves 10, 11 are closed and the steam from the stage



1 is led to the stage 2 partly through nozzles 14 and partly by way of the chamber 6, valve 9, and chamber 7 to nozzles 15. For higher speed the valves 9, 10 are closed and live steam is supplied to the stage 2 through the valve 11. At full speed, the valve 9 is closed, and live steam flows through the valve 11 to chamber 7 and through the valve 10 to chamber 8, thereby impinging on about two-thirds of the circumference of wheel 2. For a greater overload, the valves 9, 10, 11 are opened. No steam impinges on the wheel 1 in the last three modes of working. The invention is applicable also to mixed-pressure turbines, wherein live steam is supplied to the stage 1 and exhaust steam from a power installation to the pipe 12.

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CONTENTS.

EDITORIAL.

WELFARE WORK.

THE word welfare, which is one of ancient origin, has acquired a new significance during the past few years. That it does not completely signify the various undertakings for the comfort and health of workers does not signify much. It is now understood, and it certainly cannot be said that the engineering industry has lagged behind in initiating progressive movements tending to the greater well-being of the operative. In the United States far greater development has taken place, but undoubtedly in that country it has been forced on the employers in order to maintain their help. Many plants situated in beautiful but isolated parts of the country easily maintain a full roll of workers by providing an environment that is replete in everything tending to the social and healthy well-being of their operatives.

Recent development in this country has been rapid, and one can point the many instances within the past few months where the first step in the establishment of welfare work has been undertaken. The Industrial Welfare Society has done very important and useful work, and at present has over 500 firms as members, while its journal circulates among 3,000 firms. It must be absolutely clear from the start that welfare work cannot be taken up lightly or in a haphazard fashion. The scheme must be well planned, and must be carried out under the supervision of someone who possesses an aptitude for the work. An undiplomatic or tactless supervisor would antagonise the very people it is desired to embrace within the scheme. Certainly it is not a subsidiary matter, like the patronage of the works' football or cricket club. The ramifications of the work are very considerable, and any scheme at the outset cannot be entirely comprehensive. The best way is to start with one phase and build up. One of the main and most essential points is to interest everyone concerned, and to encourage active participation and constructive criticism.

The welfare supervisor, if he is up to his job, will form a link between employer and employee, and it has been pointed out that in the course of his duties he may be able to discover the special genius of those newly entering industry. It should not be necessary to say that the result of good welfare work will undoubtedly result in gain all round. One of the old-standing traditions which all those who have had experience of trade disputes will agree exist, namely, that any suggestion of the employer or employee is meant to hurt the other, will disappear. There will be a far better mutual understanding, which will reflect itself in the quality and quantity of work turned out.

WATER POWER DEVELOPMENT.

The Advantages of Water Power for Electrical Generation.

The supreme importance of water power, especially so if considered for public lighting, is the fact that as the dark season approaches, when the maximum demand for lighting comes on, our rainfall correspondingly increases in volume. Usually October is considered our wettest month, but, remarkable to say, last year, 1919, it was about the driest, December taking the record. This month being in the heart of the darkest season, when the rainfall was 7 inches, would be equal to 84 inches of rain in the 12 months, whereas in May and June the rainfall rarely exceeds 1 inch in either of these months. This is just when the demand for artificial light is at its lowest. This is a remarkable dispensation of Providence, purely to the advantage of water power; therefore, all the most remarkable it is not taken due advantage of and duly valued.

Generally in the winter time, when highest demand for current, coal is the most costly and difficult to obtain; now if this burden is to be still further increased by higher cost in transit, the sterling value of water power will be still further advanced.

If you wished to visit Mahomet 100 years ago, there was no alternative but to go to him, but now by the aid of electrical transmission you can command him to come to you, making no material difference if he be 10 or 100 miles away; but in this country, quite different to abroad, we never dream of commanding 100 miles away, rarely taking the responsibility of 10 miles.

Now, further afield we go the advantages almost outweigh the disadvantages; by the upper reaches of a stream, where the gradient is greater, land being of lean agricultural value, can be cheaply acquired. In these regions there generally exist abundance of cheap and most suitable building material—*i.e.*, stone and rock—on the spot. The tendency hitherto in this country, has been to install generating stations in the centre, or at least on the fringe of populous centres, where land is naturally very valuable, rates and wages correspondingly high. By this arrangement, current is transmitted outwardly to boundaries and beyond; but by water power the condition of things would be changed, in which case current would then be obtained principally outside municipal boundaries and focused inwardly. The most recent consideration to save principally our fuel reserves is to have 16 super large, or dreadnought, generating stations erected in this country. The intention of the Government is to pass a law enforcing this very doubtful change for economy. It would be superfluous to point out (being well understood in the electrical and mechanical world) that every change, or transformation of energy, means unavoidable loss.

The losses in water power for electrical generation and transmission may at first glance appear considerable, but they are unavoidable and face the developer at every turn; much of the energy available from the potential source, will be lost in bringing the water to, and freeing it from, the turbine, classed as mechanical and hydraulic friction. Then again, losses are sustained in every transformation, very much more so in mechanical than electrical, an account of not being controlled bya limited distance, which is the case with mechanical power. Assuming 100 H.P. in river, a loss of 20 per cent in turbine, 5 per cent in head and tail race, 7 per cent dynamo, 20 per cent in line and transformer, 9 per cent in line to car, 10 per cent in motor under car. Therefore for every 100 H.P. in river we only obtain 39 H.P. from the motor that propels tram car. These losses, though apparently heavy, are nothing in comparison with other power mediums. With steam we start with 80 per cent loss, instead of 20 per cent with water power. This shows up bad for the 16 large power stations; that is what I meant in stating, "very doubtful economy." But now the advance in the progress of water power development has materially overcome the small, though predominating, weakness of water power. I pointed out in water turbine chapter that it was now possible to obtain 100 per cent efficiency, and that the 5 per cent loss in head and tail race can be entirely eliminated.

With water power, it cannot be too forcibly borne in mind that what were considered impossibilities yesterday are to-day actual possibilities. The actuality of an ideal water power development undertaking, or anything approaching, I have not had the pleasure of making acquaintance, but it is my greatest desire to create or be the medium of bringing such about.

In addition to the possible 100 per cent efficiency, and 5 per cent in head and tail race, it must be further borne in mind that it is now possible to create a water power station without practically any extra expense; this is a remarkable achievement.

Now, if all water-courses were harnessed, generating stations would, of course, be vastly increased, some 500 to 1,000 instead of 16; but remarkable to say, the actual working expenses need be no more than with 16, as no fuel would be required. Coupled with automatic regulation of each station, one man could then look after two or three stations, instead of a regular staff at each of the 16 stations, thereby reducing working expenses to an irreducible minimum.

This would also, to a large extent, save loss in transmission and transforming, likewise cost of plant, as current would then be produced on stream and consumed locally at voltage produced, without step-up and step-down transformers.

By this arrangement, current would be transmitted inwardly from beyond municipal boundries. This completely reverses present state of things, for with steam practice the principle is to produce within boundaries and focus outwardly.

Naturally, the volume flow of water in a stream is most variable, rarely being the same two days together; this ever-occurring variation, caused by rainfall and drought, immensely diminishes the value of any stream as a source of power.

As pointed out, recent improvements in the economical development of water power has completely overcome this unreliability of flow, which has in the past been the most chronic and dearth-dealing disease of water power.

There is no such thing as waste of energy in nature; neither matter nor energy can be created or destroyed. The concussion or friction of water falling over a weir creates heat, which is not perceived

on account of its immediate dissipation in surrounding atmosphere.

Of course, the more coal increases in value, and the more labour demands, corespondingly increases the value of water power. Like many things, not only has coal increased in value, but its ash content has likewise advanced, indirectly making it still more expensive.

There is a mistaken idea that it is only black smoke that does damage; it is really the other deleterious products—*i.e.*, sulphuric and carbonic acids, that do the most serious damage to vegetation and human beings. These stifling, poisonous gases, being unseen, are consequently ignored; for every ton of coal burned there are $2\frac{1}{2}$ tons of carbonic acid belched into atmosphere—hence the mistaken notion that steam-generated electricity has no bad effect.

In the Eccles, Weaste, and Trafford Park districts—fast becoming the most industrial part of Manchester—all of which was once a huge forest, trees are dying and disappearing at an alarming rate; so much so, that it is now impossible to find a healthy beech tree in the locality.

In this district the life of wire netting and iron hurdles, if not well protected by paint and varnish, is only half of what it would be in a pure uncontaminated atmosphere; the carbon deposits from black smoke would have a preserving effect, proving clearly it is the carbonic and sulphuric acids that does the mischief.

There are few centres of population where water power cannot be profitably taken advantage of, for naturally population and industry always hugs a stream.

In short, if we do not take advantage individually or collectively, of any natural advantage placed within our reach by nature, we are bound to be the losers.

Another feature of water power: it practically costs no more to work 24 hours than it does one, live and dead expenses being the same provided there is an adequate supply of water; whereas with steam, the live expenses, *i.e.*, fuel and labour, are in direct ratio to number of hours and work done—output. Therefore, with public hydro-electrical supply, it is advisable to have demand fully up to output; for sales that will fill up hollow in load without effecting peak must be profitable, however low the charge.

The time has come when favourably located sites with abundance of water are growing increasingly valuable. The problem before the hydraulic engineer is to make available the largest possible proportion of the rainfall, and the gradient of the locality in which he is surveying for utilising efficiently any given water shed, to have a series of allied generating plants; then most profitable advantage can be taken of any considerable fluctuation of a stream.

A tendency of the times has always been to work on the accumulated flow of a stream; this is unquestionably decided bad practice. Now what is really wanted, and what I have suggested, is a coupling-up, self-regulating system.

The fortunate owner of a good power stream will find initial cost to harness far less than to put in steam plant. The cost of fuel will be nil, as none would be required: the cost of supervision and working same reduced to a minimum if plant has been well laid out and constructed, and wear and tear would then be reduced to a minimum.

Even when an engine is already at work, and there is only a small auxiliary water power available, it is both economical and prudent to make use of it. Economical, as each horse power taken from the load of the engine means a reduction of the coal bill, and prudent, in case of a breakdown or holiday.

Water Power v. Coal.

The fuel question, both liquid, gaseous, and solid, is becoming a most serious and vexed one. Therefore, it is the essential duty of every individual and nation to economise as much as possible.

The most feasible way is to effectively harness the rainfall of this country, so as to obtain its maximum usefulness, then the national saving of fuel will be on a corresponding scale to the vast amount of power developed.

Assuming the water power now running to waste was made the best use of, it would, in the British Isles at least, save the burning or some 50,000,000 tons of coal yearly, roughly one-fifth of the yearly output of coal.

Considering the death-rate by accidents in mining coal is five for every 1,000,000 tons of coal raised, the average yearly output for this country is 250,000,000, therefore the deaths by mining totals 1,250. Now, if all the water courses were harnessed and made the best of, not only would there be an enormous amount of coal husbanded, but there would be 250 lives saved.

In the past, we have unquestionably depended far too much on our coal reserves; to such a degree has this been in evidence, that our vision has become so blurred that we had become to look upon coal as our only means of carrying on the ever-increasing demands of our social economy—in the sitting-room for warmth, kitchen for cooking, in the street and on the railway for passenger and goods traffic, but the greatest drain on this ever-increasing valuable commodity, where the call is incessant day and night, the year in the year out, for the thousands of our furnaces, forges, steam engines, gasworks, coke ovens, etc.

The only way in which coal can vie with water power considered as a power medium is to sift it well, so as to extract maximum amount of valuable bye-products therefrom, which are advancing in general favour by leaps and bounds, there hardly being sufficient to meet present requirements. The recovered bye-products should approach in value, not only cost of fuel, but to cover working expenses as well, leaving the gas, the ideal fuel that can be used for 101 different purposes, as a clear asset for steam generation or power by the gas engine; then and only then can coal successfully compete with water power.

It cannot be too forcibly kept in mind that every ton of coal or gallon of oil burnt is irretrievably lost, the supply of these fuels being far from infinite.

Whereas, with water power, conditions are completely changed by sun heat, evaporation causes a complete cycle of continual replenishment.

The production of alcohol is in the same catagory, but in no comparison as to cheapness, with no prospects of its commercial production in this country, though many contend and strongly desire otherwise for power purposes.

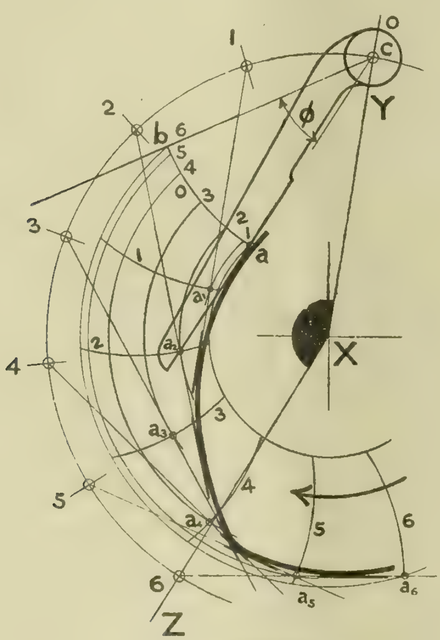
(*To be continued.*)

CAMS.

By W. E. BENNISON, A.M.I.M.E.

(*Continued from page 194.*)

X. Constant acceleration and retardation velocity: surface contact; angular movement.—Fig. 39 shows the construction adopted for this type. The surface is part of the free end of a lever which is fulcrumed at *c*. Under pressure of the cam the lever is moved through the angle ϕ. As there is no definite follower path one will have to be imagined. Any point *a* on the surface is selected, and an arc is down through this point. This arc is now treated as the follower path, and the point *a* will travel along it until it reaches the point *b*, which is the intersection of the arc with the extreme outward position of the surface. The treatment is now similar to that already described for levers. Z X Y is the cam angle, and the line X Y is drawn through the

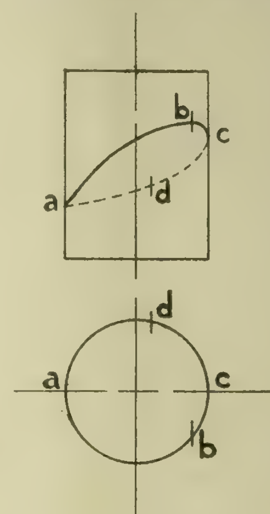


CAMS.—FIG. 39.

fulcrum *c*. The fulcrum is revolved contrary to the cam's rotation, therefore its final position will be on the line X Z. The intermediate fulcrum positions are equidistant as before described; in the example the fulcrum positions are numbered 0 to 6. With radius *c a* from every fulcrum describe an arc, and give each arc the same number as the centre from which it is struck. The arcs thus obtained give the various positions for the follower path *a b*. The position of point *a* has now to be found on every arc. The motion of the point *a* along its path will be constantly accelerated until the lever has advanced through the angle $\frac{\phi}{2}$ and then for the remainder of the stroke it will be constantly retarded. The displacement curve, Fig. 38, is the one to use, and the points on the curve *a b* are otbained from it exactly as described in the last case. Arcs are now drawn through these points cutting the curved follower paths bearing the same numbers, thus determining the position of point *a* on every arc. The surface always passes through the point *a*; if produced it also passes through the fulcrum. Lines are therefore drawn through every position of the point *a* to the fulcrum position carrying the same number as follows:—A straight line is drawn from a_1 to fulcrum 1, from a_2 to fulcrum 2, from a_3 to fulcrum 3, and so on to 6. These straight lines give the various positions for the surface which must all be tangent to the cam curve. The curve is then drawn touching the surface positions.

Standard lay-out for Helical Cams.

The lay-out for the helical cam will now be dealt with. The principles are the same as for a spiral cam, viz.,

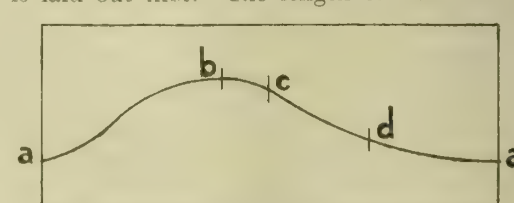


CAMS.—FIG. 40

the follower path is revolved round the axis in the opposite direction to the rotation, and at the same time the follower is made to move along that path: the only differences are geometrical ones.

The spiral curve being all in one plane can be drawn flat upon the paper. The helical curve is traced upon the surface of a cylinder and cannot be represented on a flat plane except by developing the cylinder surface. This is the means adopted in laying out helical cams.

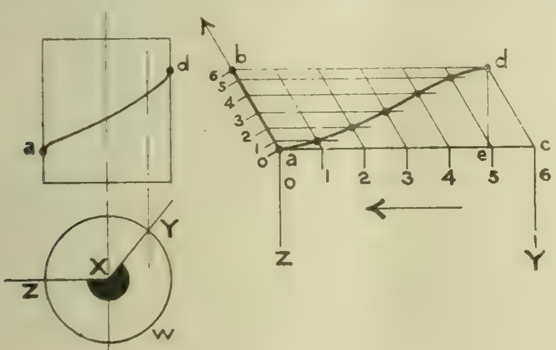
Fig. 40 shows a cylinder with a curve *a b c d* traced completely round its circumference commencing at the point *a* and returning to that point. Fig. 41 shows the surface of the cylinder laid out flat and the curve *a b c d* developed. In laying out a helical cam the development is laid out first. The length of the development



CAMS. —FIG. 41.

is made always equal to the circular measure of the cam angle and its length may be anything up to 2π radius (360 deg.). To obtain the exact appearance of the helix wrapped round the cylinder is, of course, a matter of projection from the development. In practice it is seldom necessary to do this; an approximation is all that is shown in the cylindrical view and all the exact data are given on the development. It is this development that the setter out and machine man work to in constructing the cam.

Fig. 42 shows the standard lay-out for a helical cam. It is desired to move the follower (which is again taken to be a point) along the line *a b* while the cam is sweeping through the angle Z X Y. Let the line *a c* in the development be the circular measure of the cam angle. In reality *a c* is made equal to the arc subtended by the angle Z X Y at the circumference of the cylinder, that is, the arc Z W Y. For convenience *a c* is usually drawn horizontal. Bearing in mind the general rule previously laid down the follower path *a b* must be revolved round the axis of the cam in a direction opposite that of rotation. In Fig. 42 the cam rotates from *c* to *a*. If the point *a* is moved along the line *a c* and the line *a b* maintained at constant inclination, that is, equivalent to revolving *a b* through the cam angle, *c d* will be the final position of *a b*. The intermediate positions must be equidistant as in the case of the spiral cam: in the present case six divisions are taken and numbered 0 to 6, commencing with the point *a*. Each follower path position will be a line parollel to *a b*. To space out the points on the follower path *a b* the procedure is exactly the same as for spiral cams; they are positioned to give the required velocity to the follower. In the present instance six spaces are taken because there are six divisions of the cam angle, and the points are numbered 0 to 6. These



Cams.—Fig. 42.

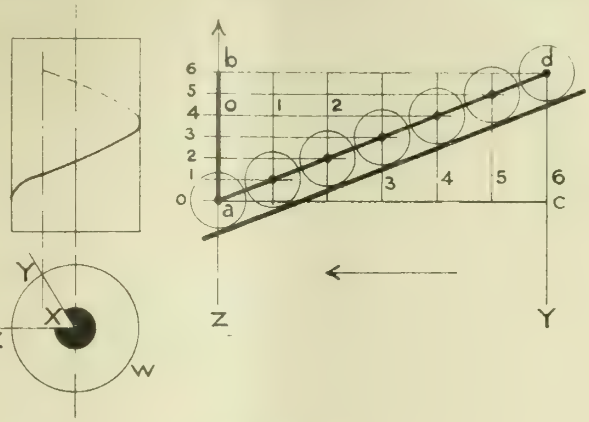
points must now be projected on their own follower paths. This is done by drawing a line through every point parallel to *a c* cutting the follower path of the same number: thus through point 1 a line is drawn parallel to *a c* cutting follower path 1; through point 2 a parallel line is drawn cutting follower path 2; and so on. The intersections thus obtained give points on the cam curve. The curve *a d* thus obtained is the development of the required helix. In wrapping this helix round the cylinder the line *a c* will be wrapped round to form the arc of a circle whose plane is at right angles to the cam axis.

In the particular case shown in Fig. 42 attention is directed to the two following points:—The angle (*a e*) subtended by the helix is not equal to the cam angle; and the throw of the cam (*e d*) is not equal to the stroke of the follower (*a b*).

Various Examples.

A few examples of helical cam lay-outs follow.

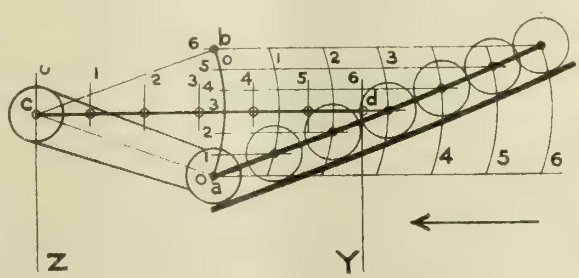
XI. Uniform velocity: roller contact; rectilinear motion, parallel to axis.—The lay-out for this type is shown in Fig. 43. The line *a c*, being the circular measure of the cam angle, is made equal to the arc Z W Y. The follower path *a b* is parallel to the axis, and it will therefore be at right angles to *a c*. *a b* is revolved round the cam axis by moving it along *a c* in a direction opposite to the arrow; *c d* will be its final position. Between *a b* and *c d* any number of equidistant positions are found: six are taken here, as before, and are numbered 0 to 6. Each position will be at right angles to *a c*. The follower path *a b* is now divided



Cams.—Fig. 43.

into six equal parts, and the divisions numbered 0 to 6. Each of these points, if projected by means of a line parallel to *a c* on to the follower path of the same number, will give a point on the true cam curve. Circles described about these points of the same diameter as the rollers give the various positions of the roller. The true cam curve passes through the centres of the rollers and the actual can curve is tangent to the rollers. Both are straight lines. It will be noticed that the actual cam curve is also the displacement curve, and also that when wrapped round the cylinder it will become a regular helix.

XII. Uniform velocity: roller contact; angular movement.—The roller in this case is carried by the free end of a lever fulcrumed at the point *c*. The layout is shown by Fig. 44. The follower path is the circular arc *a b* and as drawn the motion is approximately parallel to the axis. The line *c d* is made equal to the circular measure of the cam angle at the circumference of the cylinder. It is necessary to revolve the arc *a b* around the axis, and this is done by moving it in a direction opposite to the arrow. The procedure is similar to that adopted for spiral cams, viz., positions are first found for the fulcrum and the acres struck from them. If the fulcrum *c* is moved along the line *c d* it is equivalent to



Cams.—Fig. 44.

revolving it through the cam angle, and the point *d* will be its final position. To find the intermediate fulcrum positions the line *c d* is divided into any number of equal parts; six are here taken, and they are numbered 0 to 6. From each fulcrum position with radius *c a* (the length of the lever) an arc is struck; each arc

represents a position of the follower path and is given the same number as the centre from which it is struck. The arc *a b* is now divided into six equal parts, and from every point a line is drawn parallel to *c d*, cutting the follower path of the same number: thus through point 1 on *a b* a parallel line is drawn cutting arc 1; through point 2 a line is drawn cutting arc 2; and so on. The intersections thus obtained give the centres of the roller. About these centres circles are drawn to represent the roller in its various positions. The true cam curve passes through the roller centres and the actual cam curve touches all the roller circles. This is the cam curve development. The curve approximates to a straight line, but it is not quite straight, as inspection of the diagram will show.

(To be continued.)

A NEW THEORY OF PLATE SPRINGS.

By David Landau and Percy H. Parr.

(Concluded from page 248.)

As a simple illustration, for a mental physical conception, we may take, say the two-plate spring shown in Fig. 5. When these two plates are bolted together at the centre, the master leaf is deflected *upwards*, or negatively; the short plate, on the other hand, is deflected *downwards* or positively (in the same direction as it is deflected by the external load) and hence there is a negative stress produced in the master leaf and a positive stress produced in the short leaf during the manufacture—all before any external load is placed on the completed spring.

Suppose we now deflect this spring positively, as by placing an external load on it, then both leaves move in the positive direction, and when the master leaf has been deflected a distance equal to the initial negative deflection due to the nipping load, it will have (at certain places) zero stress, while at the corresponding deflection the stress in the short plate is positive and is equal to the sum of the nipping stress and the load stress. The total stresses and the stress variations are quite different for the two plates; the range of stress in each is determined by the external load and is the same as if the nip had not been introduced, but the total or maximum stress and, more particularly, the life depends both on the nip and on the external load.

The life of any leaf in a spring evidently depends both on the maximum stress to which it is submitted and on the "range" or the stress variation. From the theory, as developed above, we can calculate with accuracy both of these factors, and so in a similar manner we ought to be able to predict the life of each and every plate. It is the custom (at present) to consider the life of the spring, as a whole, to be that of the shortest life of any of the plates of which it is composed. The ideal spring would be the one in which all of the plates except the master plate had the same life, while for practical considerations the master plate had a life slightly in excess of the others. This last condition should prevail because the master leaf is the most important, it being the one which is directly connected to the vehicle. So long as the master leaf exists intact then the vehicle may run quite a distance with care and at slow speed, whereas if the master plate was fractured the car could not be run at all. (See Landau, United States Patent No. 1,199,013, issued September 19th, 1916.)

Endurance of Materials under Varying Stress.

The question of the endurance of materials under fluctuating stress is of considerable practical and theoretical importance, but unfortunately up to the present time there has never been any satisfactory solution correlating the endurance and stress range relation; we have studied much of the available information, both old and new, without finding anything that will give a very definite answer to the question for our needs, which is, to predict the life when the stress variations are known. We have tried many of the existing formulæ and have carefully compared the results as given by them with the results obtained on the endurance testing machines, and as the result of our study we have found that for present purposes and, with the present state of our knowledge, the parabolic relation of Gerber, based on a study of Wöhler's tests on materials subjected to varying stresses, gives an answer more nearly in accordance with the observed facts than any of the other formulæ. Gerber's formula, however, does not succeed in giving the relative life of the various plates; it does appear to be able to predict with reasonable accuracy which of the plates will break the first—the curve of relative liability to breakage for the various plates composing a spring as given by the use of Gerber's relation is quite similar to that obtained by plotting the results of destruction tests on more than 500 springs—but the actual numerical relations are, however, still considerably in error. In the absence of more accurate information and with the present state of our knowledge we shall, for the time being, make use of the Gerber relation.

Gerber's formula is*

$$F = \frac{R}{2} + \sqrt{f^2 - nRf} \ldots\ldots\ldots\ldots (56)$$

in which

F = the maximum stress intensity,
R = the range of stress,
f = the ultimate strength of the material, and
n = a constant to be determined from practice
= about 2 for hard steels.

The form in which this equation is given is not convenient for our purpose, and we have found it better to write

$$R = aF$$

where

$$a = \frac{\text{maximum stress} - \text{minimum stress}}{\text{maximum stress}}$$

we may then write

$$F = \frac{2f\left(\sqrt{n^2a^2 + (2-a)^2} - na\right)}{(2-a)^2} \ldots\ldots (57)$$

$$= \text{say } bf.$$

where b is a function of a and n $(=2)$ only.

The limits for a are evidently zero and 2, corresponding to static loads and to reversed loads of equal amounts respectively. For $a = 2$, equation (57) fails to give a direct answer, as it leads to the indeterminate form 0/0, but by referring to the original equation (56) it is at once seen that for this case $b = \frac{1}{2n}$, or $\frac{1}{4}$ for the hard steels.

* See Unwin, "Elements of Machine Design," Vol. I., chapter 2.

In order to facilitate the application of this theory to plate springs, Table VIII. has been calculated, giving the values of b corresponding to values of a varying by 0.02 for the complete range from 0 to 2.

We will now apply this to the Liberty B front spring. The nipping loads and relations between the reactions and the external loads have already been given. The external load for which the spring was designed is 2,000 lbs. With reference to the values of I and Z (the moment of inertia and the modulus for bending); the plates have rounded edges and are slightly concave, so that the values of I and Z are slightly less than they would be for rectangular plates.* A careful calculation shows that for the 3 in. $\times$ $^5/_{16}$ in. plates I = .006687 and Z = .04280, while for the 3 in. $\times$ $\frac{3}{8}$ in. plates I = .01169 and Z = .06236.

Making use of these figures, it will be found that the stresses and stress ranges for the different plates composing the spring are as follows:—

n	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
1	1133	491	642	.56	.679	1358	1.20	1.44
2	825	350	475	.58	.666	1332	1.62	1.07
3	660	238	422	.64	.635	1270	1.93	.90
4	543	144	399	.74	.584	1168	2.15	.80
5	480	93	387	.80	.555	1110	2.31	.75
6	414	25	389	.94	.496	992	2.40	.72
7	320	−60	380	1.18	.412	824	2.58	.67
8	209	—168	377	1.80	.278	555	2.67	.65
9	249	−325	574	1.76	.284	568	1.75	.99
10	136	−438	574	1.30	.378	756	1.73	1.00

In the above table the column n is the number of the plate under consideration, counting from the shortest plate, which is called No. 1.

Column I. is the stress due to both the nipping and the external loads in thousands of pounds per square inch.

Column II. is the stress in thousands of pounds per square inch due to the nipping loads only.

Column III. is the range of stress or the difference between Column I. and Column II. again in thousands of pounds per square inch.

Column IV. is a, or the range of stress (Column III.) divided by the maximum stress (Column I. or II., as the case may be).

Column V. is b, as found from Table VIII. for the corresponding value of a.

Column VI. is the useful working stress (ultimate) as determined by multiplying the ultimate strength of the material, assumed to be 200,000 lbs. per square inch, by the corresponding b of Column V.

Column VII. is the factor of safety, as determined by dividing the figures of Column VI. by those of I. or II., whichever may happen to be the greater.

Column VIII. is the relative liability to fracture of the various plates, being proportional to the reciprocals of Column VII., according to the Gerber expression before mentioned. These are the most interesting since they give the relative probabilities of the breakage of the various plates when the liability of breakage of the master leaf is taken as unity.

It is to be noticed that the stress variations and breakage liabilities as given above have been calculated for the case when the external load is alternately fully applied and completely removed. In actual operation the load fluctuation is usually from something under to something over the normal, with an occasional total removal, and even reversal, on the rebound after the wheels of the vehicle have encountered an obstacle: The relative lives of the different plates will be found to be different, according to the particular load variation adopted as the basis of calculation, but, on the whole, it will be similar to that obtained by taking the load variation as being from zero to full load alternately, and in the absence of absolute information as to the actual average variation we have made the calculations of the basis mentioned.

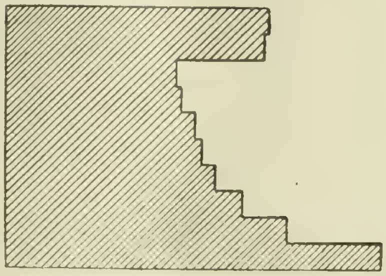


PLATE SPRINGS —FIG. 33

The results of the calculation are shown by Fig. 33, from which the relative liability to breakage is more readily appreciated than it is from looking at the table given above. It is seen that the short plate is by far the most likely to fracture, and also that there is a considerable liability for the master and the long plates to break. This is quite in accordance with the results of observations of other springs both on the endurance testing machines and in service.

Fig. 34 shows the average relative liability to breakage for the various plates of plate springs, as determined by a careful study of more than 500 fractures. It will at once be noticed that the general

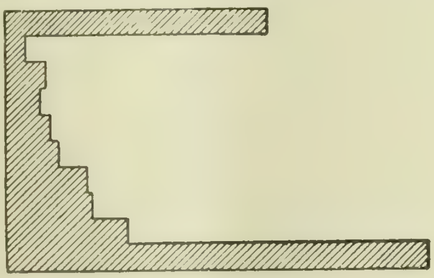


PLATE SPRINGS.—FIG. 34.

form of the calculated liabilities as shown by Fig. 33 is quite similar to the observed liabilities as shown by Fig. 34, but that the middle plates do not, in pratice, break with such frequency as would be indicated by the calculations. This is the justification for our earlier remark that the theory appears to give a fair idea as to which plate will break first and some idea of the relative liability, but that it does not give the relative liabilty to fracture with any great degree of accuracy. In the present state of knowledge regarding the effects of alternating stress on materials, this appears to be as far as it is possible to go; later on, when the question of alternating stresses has been further advanced by investigations

* We would draw attention to the fact that nearly all actual spring steel bars are rolled slightly concave in the thickness and with rounded edges, so that the moment of inertia I and the strength modulus Z are less than for a rectangular bar. The reduction is greater than is usually appreciated, being in the neighbourhood of 10 per cent on an average, and reaching 14 per cent with some sections; for accurate results it is therefore necessary to use the true values of I and Z in our formulæ, and not to consider the section as rectangular, which may lead to very serious errors.

now under way by others, we may expect to be able to predict with absolute certainty the relative liabilities to fracture of the various plates and to design springs which will be perhaps theoretically and practically perfect; in the meantime, we can say that our "New Theory of Plate Springs is as perfect as present-day knowledge permits—especially that portion of it which deals with the question: "How long will any spring endure?" This phase of the problem is only an extension of the general reasoning of our "New Theory of Plate Springs" which the second paper has so carefully expounded.

TABLE VIII.

Max-min. / max.	Factor	Max-min. / max.	Factor	Max-min. / max.	Factor
.00	1.000	.70	.604	1.40	.353
.02	.990	.72	.594	1.42	.348
.04	.980	.74	.584	1.44	.343
.06	.969	.76	.574	1.46	.339
.08	.958	.78	.564	1.48	.335
.10	.948	.80	.555	1.50	.331
.12	.937	.82	.546	1.52	.327
.14	.926	.84	.537	1.54	.323
.16	.914	.86	.529	1.56	.319
.18	.902	.88	.520	1.58	.315
.20	.891	.90	.512	1.60	.311
.22	.879	.92	.504	1.62	.307
.24	.868	.94	.496	1.64	.303
.26	.856	.96	.488	1.66	.299
.28	.844	.98	.480	1.68	.296
.30	.832	1.00	.472	1.70	.293
.32	.821	1.02	.465	1.72	.290
.34	.809	1.04	.458	1.74	.287
.36	.797	1.06	.451	1.76	.284
.38	.784	1.08	.444	1.78	.281
.40	.772	1.10	.437	1.80	.278
.42	.760	1.12	.431	1.82	.275
.44	.749	1.14	.424	1.84	.272
.46	.737	1.15	.418	1.86	.269
.48	.725	1.18	.412	1.88	.266
.50	.714	1.20	.406	1.90	.263
.52	.703	1.22	.400	1.92	.260
.54	.691	1.24	.394	1.94	.257
.56	.679	1.26	.388	1.96	.254
.58	.666	1.28	.383	1.98	.252
.60	.656	1.30	.378	2.00	.250
.62	.646	1.40	.373		
.64	.635	1.42	.368		
.66	.625	1.44	.363		
.68	.614	1.46	.358		

(Concluded.)

COAL CONSERVATION AND ELECTRIC POWER SUPPLY.

(Concluded from page 250).

Reasons for Establishing a Co-operative Electric Power System.

The advantages of some co-operative electric power systems are at once apparent when it is considered: —

(*a*) That the production of power is becoming more and more a specialised process;

(*b*) That the most economical generation of power is only possible with larger units, and with a better and more constant load factor than most individual establishments can employ. Also, the capital expenditure for the total horse power required in the country would be greatly reduced;

(*c*) That in large power stations, equipped with the largest and most modern units, and superintended by specially-trained fuel and power engineers, it is possible to burn under the boilers, with good average results, *inferior* grades of coal which could not otherwise be utilised at all. Also, that the recovery of by-products would be more feasible in connection with such stations than with small private plants;

(*d*) That co-operative production means that the small manufacturers and rural industries generally will have cheaper power at command. Also, that an electric motor would soon become an indispensable part of the equipment of every house—a great boon to overworked housewives.

Inefficiency of the present System of Electric Power Supply.

The present system of electrical power distribution throughout the country, which is undertaken by over 600 authorities in as many separate districts, is technically wrong and commercially uneconomical. It is as though our railway system were composed of innumerable small undertakings (municipally or privately owned) with half-a-dozen different gauges indiscriminately laid out, so that it was impossible to run a through service of goods or passenger trains between, say, London and Manchester, or Bristol and Newcastle. Also, the average size of the existing generating stations (5,000 H.P.) is only about one-fourth what should be the smallest machine in a modern public station.

Hitherto, local jealousies, as well as vested interests, which our lawyer-ridden Parliament has fostered far too much, have blocked, and are still blocking, the way. How often in the past, in connection with water, gas, and electric light schemes, has Parliament encouraged the formation of small rather than of large and more efficient undertakings? —a policy which has proved as disadvantageous to the community at large as it has been profitable to the lawyers who frequent the Parliamentary Bar.

A typical example of this sort is afforded by the public electricity supply for Greater London (area, 693 square miles; population, 7¼ millions), in which there are, or were recently, no less than 65 separate authorities supplying electricity, upon 49 different systems, from 70 generating stations containing 585 engines, and distributed at 24 different voltages to the consumer, who is charged at one or other of over 70 different rates and prices! Thus, as a resident within the area, I am being charged the truly astonishing price of 7½d. per unit for current at my house,* and Londoners, as a whole, pay very dearly for a most inefficient electric supply, which ought to be thoroughly overhauled and reorganised.

The average size of the generating stations is only 5,285 kw., and of the generating units only 632 kw. Many of the older stations contain reciprocating engines, and some have even to cart their coal—a truly ridiculous state of affairs. But, notwithstanding these disadvantages, London's demand for

* Since the lecture was delivered, I have received notice implying that this may be increased to 10d. per unit, a perfectly preposterous figure.

current per head of the population has increased five-fold since 1900, and is still expanding. There is probably no other area in the world which, in regard to density of population, easy access by sea to abundant fuel, and possibilities in the way of rapidly-expanding demands for electricity both for power and lighting, is more admirably adopted for the development of a public supply of cheap electricity under a single authority, with consequent great economy of fuel and in the cost of production generally. How long will the people of London allow these natural advantages to be nullified by the short-sighted policy which has prevailed hitherto?

With regard to the country as a whole, there can be no doubt but that, even in the best-managed power plants, whether company or municipally owned, coal is being needlessly wasted, chiefly on account of *(a)* the small size of generating stations and units; *(b)* unsatisfactory load factor, and *(c)* bad location of many of the plants in regard to condensation facilities. Thus, the average coal consumption of some of the principal Lancashire and Cheshire electric supply systems has been given as 3·275 lb. per kw. generated, whilst a few weeks ago Mr. W. Wilson, Technical Adviser to the Coal Controller, stated at a meeting of the Junior Institution of Engineers, that during the year ending March 31st, 1918, 421 electric supply undertakings in the Kingdom generated 4,674 million kw. units with an average consumption of 3·47 lb. of coal per kw. But, under the best conditions now possible, it need not to have exceeded 2·0 lb. kw., and probably in the near future it will be possible to do it for not more than 1·75 lb.

The Coal Conservation Committee's Proposals.

The Coal Conservation Committee (Power Section) having considered the whole question from a technical standpoint, made certain recommendations concerning the post-war organisation of public power supplies which, having been substantially endorsed by the Board of Trade Electric Supply Committee, will probably form the basis of legislative proposals in the near future.

It is proposed:—

(a) To divide the country into a limited number of areas (16 are suggested), throughout each of which there shall be a standard periodicity and trunk main voltage;

(b) That the generating plants and units within each area shall be of the largest size required to ensure the maximum fuel economy and general efficiency in working. Units of not less than 20,000 H.P. ought to be used, and in the largest stations 50,000 H.P.;

(c) That such plants shall be put down in the most favourable place or places for economical generation *(e.g.*, at the pithead if a very inferior coal has to be used, or near a river or estuary where condensation facilities are best);

(d) That the main trunk system shall collect any waste power (surplus gas or waste heat) available, which (after conversion into electric current) shall be distributed to where it can be most profitably used.

Choice of Prime Movers. Gas or Steam Engines for Power Station Work.

We shall not be far wrong in assuming for our present purposes that the heat equivalent of the available energy in 1 lb. of a good average coal is 13,000 B.Th.U.s. Inasmuch as the heat equivalent of a horse-power is 2,564 B.Th.U.s, it follows that, were we able by any means to transform the available energy in coal into mechanical power without loss of any kind, we should obtain a horse-power-hour output of work by the expenditure of about 0.2 (one-fifth) lb. of coal.

There are two principal ways in which we may convert the energy of coal into mechanical work. One is by raising steam in a boiler and then utilising as much as possible of the energy of the steam in some form of steam engine, either of the reciprocating or turbine type; the other is by gasifying the coal completely in some form of gas-producer, where the incandescent fuel is converted into a mixture of CO_2, CO, H_2, CH_4, and N_2, under the action of a steam and air blast, and then burning the resulting gas in an internal-combustion engine. Both these methods are imperfect, of course; but it may, perhaps, be of interest if we compare them from the point of view of thermal efficiency.

In the first place, the thermal efficiency of a good modern type of coal-fired boiler is not far short of that of the gasification of coal in a gas producer, when allowance is made for the fact that it is necessary to clean and cool the resultant gas before it is delivered to the engine. We shall not be far wrong in putting down the efficiency of each method under good working conditions at about 75 per cent. Now, under favourable working conditions, a gas engine will convert about 27 per cent of the energy of the gas supplied into available horse-power, so that the coal consumption required to obtain a shaft-horse-power-hour by means of the combination of an efficient gas producer and a gas engine need not be more than 1 lb.—

$$\frac{0{\cdot}20}{0{\cdot}75 \times 0{\cdot}27} = 1 \text{ lb. per b.h.p. hour.}$$

Fifteen years ago the efficiency of the best type of reciprocating engine was not more than about 13·5 per cent; so that the combination of the best steam boiler and engine of that day did not convert more than, perhaps, 10 per cent of the available energy of the coal into shaft-horse-power. Hence the coal consumption of such a system would be—

$$\frac{0{\cdot}20}{0{\cdot}75 \times 0{\cdot}135} = 2{\cdot}0 \text{ lb. per b.h.p. hour.}$$

During recent years such great advances have been made in the development of the steam turbine that it has for the time being entirely out-distanced the gas engine as a "power-station" machine, except for comparatively small units of, say, less than 3,000 B.H.P. capacity. According to the published results of trials on the new 35,000 H.P. Parsons turbo-alternator, erected at the Fisk Street power station in Chicago, the fuel consumption on so large a turbine steam set (assuming a boiler efficiency of 75 per cent) has now been reduced to 1 lb. of coal per shaft-horse-power-hour; so that there is now probably little to choose between the thermal efficiencies of the best types of steam and gas systems, each working under the most favourable conditions. But from the point of view of the size of units, the turbine has shot far ahead of its rival (the large Parsons turbo-alternator recently installed at Chicago is 35,000 H.P. capacity, far surpassing anything yet attempted with an internal-

combustion engine unit). And whereas a gas engine only works at its highest efficiency with a high load factor, a turbine maintains its efficiency over a wider range of load than its rival, and at low load far surpasses it. A gas engine requires much more lubrication, but, on the other hand, usually less cooling water than the turbine; and, owing to its simpler construction, the turbine requires less adjustment and repairs, and is more reliable than its rival.

These considerations have led to the almost universal adoption of the steam turbine for large power stations, except in cases where there are available supplies of surplus gases from coke-ovens, blast-furnaces, or the like. On the other hand, for comparatively small units—say up to 3,000 H.P.—where the load factor is uniformly high and not subject to abrupt variations, the gas engine has certain advantages. In any case, however, the choice between the two rival systems will not usually be determined on purely thermal considerations, but on the other equally important factors.

The Economy of Large Generating Stations.

The economy of large generating stations may be ascribed to the following factors, namely:—

(*a*) Better condensation facilities;

(*b*) The employment of much larger generating machines with higher boiler pressures (450 lb.), and complicated but more efficient steam cycles. High boiler pressures, with large turbo-alternators, give greater thermal efficiencies than are possible on any combination in smaller sets; for very high steam pressures are not economical with small turbines, because of the larger proportionate clearances;

(*c*) The use of very large machines, employing complex steam cycles, is not justifiable unless the "load factor" is good (which should be at least 50 per cent or more), and a good "load factor" is hardly possible except in case of large public stations generating current for the requirements of a wide area.

As an example of the fuel economy now attainable in large stations, I am permittted to say that in one of the largest public power stations in Great Britain the actual development of heat by the combustion of a very inferior grade of coal in the boilers per kw. sent out of the station does not exceed 19,500 B.Th.U.s, under ordinary daily working conditions, which corresponds to a thermal efficiency of 1[illegible] per cent; also, that in a large super-station now in course of erection in the country, and which will probably be in operation by the end of the present year, the plant has been so designed that it is confidently anticipated that no more than 16,000 B.Th.U.s will be expended per kw. sent out. The efficiency will therefore be quite 20 per cent on the current sent out.

Conclusion

If, then, it be conceded that, from a national standpoint, co-operative power production in large central stations is the right policy for this country, it seems to me difficult to resist the conclusions (1) That the power ought to be generated preferably from low-grade coals, burnt under expert supervision in large boilers with high pressures and "super-heat"; (2) that the "superheated" high pressure steam should be utilised for generating electricity in large turbo-alternators, with good condensation facilities; and (3) that the electricity so generated should be distributed as high-tension current through public mains over a radius up to (say) 20 miles from the generating station.

I cannot see, nor has it yet been demonstrated, that public gas distribution offers any practicable alternative solution of the power problem, and I regard the present opposition of the gas interests to the idea of electric power distribution as purely obstructive and reactionary.

[The lecture concluded with an exhibition of lantern slides and data relative to (*a*) the North-East Coast Electric Power Scheme, as a typical example of what may be accomplished in the way of co-operative power generation, and (*b*) the application of electric power in driving rolling-mills in steelworks.]

(*Concluded.*)

PRODUCER GAS FOR MOTOR VEHICLES.

By D. J. SMITH.

(*Concluded from page 253.*)

Waste Gas Analysis.

When a vehicle fitted with a producer is standing with the engine stopped, it is advisable to open the gas test cock or the fuel feeder opening to allow ventilation to the fire and so tend to keep it in a condition suitable for rapid starting. It was therefore considered necessary to ascertain the composition and volume of the gases which would be emitted under those conditions, and these are shown in Table V. In considering this it should be remembered that there is no flow of steam through the fire while the plant is standing. The most important point is the volume, which was gauged at 10 cubic feet per hour, and this, when the vehicle is standing in the open, can be regarded as negligible. When standing in a garage, it is certainly less dangerous than the engine exhaust of a vehicle, but it is nevertheless advisable to provide good ventilation in any garage where such vehicles are housed.

TABLE V.

	Gas off 3-way Vent. Cock, after returning home. Engine stopped.			
	1st Sample. per cent.		*2nd Sample.* per cent.	
Carbon Di-oxide	2·20	After 5 minues' stoppage.	5·20	After 10 minutes' stoppage.
Free Ozygen	1·20		3·70	
Carbon Monoxide	7·00		11·70	
Heavy Hydro-carbons	Nil		Nil	
Nitrogen	80·00		52·00	
Combustilble matter	0·60		25·50	

Danger from Fire.

The danger from fire due to the use of producer gas is very remote, though it would certainly be inadvisable to light or to rake out the fire in an ill-ventilated garage containing petrol vehicles. Fire could only occur from some outside cause such as a leakage of petrol in the garage in which the producer gas vehicle was standing. While the engine is running, there is no chance of fire, but with the producer open, petrol vapour, if present, might be ignited. It would, therefore, be advisable not to house petrol and producer gas vehicles in the same shed at night, unless very well ventilated. In this respect, however, the producer gas vehicle would be a much safer companion for a petrol vehicle than a steam lorry.

In this connection, the Inter departmental Committee on the employment of gas as a source of power, in their recommendation No. 37, make the following statement:—

"A vehicle deriving its power from a portable, self-contained, suction gas producer should not be housed under living rooms in human occupation, or while the fire is alight be stored overnight in the same building or enclosed structure as a petrol driven vehicle."

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 74 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 2 12	13 0 24	0 19 3 8	1 6 1 20	1 13 0 4	1 9 2 16	2 6 1 0	2 12 3 12	2 19 1 24	0
1	0 2 18	7 1 2	13 3 14	1 0 1 26	1 7 0 10	1 13 2 22	2 0 1 6	2 6 3 18	2 13 2 2	3 0 0 14	1
2	1 1 8	7 3 20	14 2 4	1 1 0 16	1 7 3 0	1 14 1 12	2 0 3 24	2 7 2 8	2 14 0 20	3 0 3 4	2
3	1 3 26	8 2 10	15 0 22	1 1 3 6	1 8 1 18	1 15 0 2	2 1 2 14	2 8 0 26	2 14 3 10	3 1 1 22	3
4	2 2 16	9 1 0	15 3 12	1 2 1 24	1 9 0 8	1 15 2 20	2 2 1 4	2 8 3 16	2 15 2 0	3 2 0 12	4
5	3 1 6	9 3 18	16 2 2	1 3 0 14	1 9 2 26	1 16 1 10	2 2 3 22	2 9 2 6	2 16 0 18	3 2 3 2	5
6	3 3 24	10 2 8	17 0 20	1 3 3 4	1 10 1 16	1 17 0 0	2 3 2 12	2 10 0 24	2 16 3 8	3 3 1 20	6
7	4 2 14	11 0 26	17 3 10	1 4 1 22	1 11 0 6	1 17 2 18	2 4 1 2	2 10 3 14	2 17 1 26	3 4 0 10	7
8	5 1 4	11 3 16	18 2 0	1 5 0 12	1 11 2 24	1 18 1 8	2 4 3 20	2 11 2 4	2 18 0 16	3 4 3 0	8
9	5 3 22	12 2 6	19 0 18	1 5 3 2	1 12 1 14	1 18 3 26	2 5 2 10	2 12 0 22	2 18 3 6	3 5 1 18	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6·17	12·34	18·51	24·68	1 2·85	1 9·02	1 15·19	1 21·36	1 27·53	2 5·7	2 11·87	2 18	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 74 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 6 0 8	6 12 0 16	9 18 0 24	13 4 1 4	16 10 1 12	19 16 1 20	23 2 2 0	26 8 2 8	29 14 2 16	0
10	0 6 2 12	3 12 2 20	6 18 3 0	10 4 3 8	13 10 3 16	16 16 3 24	20 3 0 4	23 9 0 12	26 15 0 20	30 1 1 0	10
20	0 13 0 24	3 19 1 4	7 5 1 12	10 11 1 20	13 17 2 0	17 3 2 8	20 9 2 16	23 15 2 24	27 1 3 4	30 7 3 12	20
30	0 19 3 8	4 5 3 16	7 11 3 24	10 18 0 4	14 4 0 12	17 10 0 20	20 16 1 0	24 2 1 8	27 8 1 16	30 14 1 24	30
40	1 6 1 20	4 12 2 0	7 18 2 8	11 4 2 16	14 10 2 24	17 16 3 4	21 2 3 12	24 8 3 20	27 15 0 0	31 1 0 8	40
50	1 13 0 4	4 19 0 12	8 5 0 20	11 11 1 0	14 17 1 8	18 3 1 16	21 9 1 24	24 15 2 4	28 1 2 12	31 7 2 20	50
60	1 19 2 16	5 5 2 24	8 11 3 4	11 17 3 12	15 3 3 20	18 10 0 0	21 16 0 8	25 2 0 16	28 8 0 24	31 14 1 4	60
70	2 6 1 0	5 12 1 8	8 18 1 16	12 4 1 24	15 11 2 4	18 16 2 12	22 2 2 20	25 8 3 0	28 14 3 8	32 0 3 16	70
80	2 12 3 12	5 18 3 20	9 5 0 0	12 11 0 8	15 17 0 16	19 3 0 24	22 9 1 4	25 15 1 12	29 1 1 20	32 7 2 0	80
90	2 19 1 24	6 5 2 4	9 11 2 12	12 17 2 20	16 3 3 0	19 9 3 8	22 15 3 16	26 1 3 24	29 8 0 4	32 14 0 12	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	33 0 2 24	66 1 1 20	99 2 0 16	132 2 3 12	165 3 2 8	198 4 1 4	231 5 0 0	264 5 2 24	297 6 1 20	330 7 0 16	

COMPILED AND ARRANGED BY T. E. WOODHOUSE

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 75 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 2 22	13 1 16	1 0 0 10	1 6 3 4	1 13 1 26	2 0 0 20	2 6 3 14	2 13 2 8	3 0 1 2	0
1	0 2 19	7 1 13	14 0 7	1 0 3 1	1 7 1 23	1 14 0 17	2 0 3 11	2 7 2 5	2 14 2 27	3 0 3 21	1
2	1 1 10	8 0 4	14 2 26	1 1 1 20	1 8 0 14	1 14 3 8	2 1 2 2	2 8 0 24	2 14 3 18	3 1 2 12	2
3	2 0 1	8 2 23	15 1 17	1 2 0 11	1 8 3 5	1 15 1 27	2 2 0 21	2 8 3 15	2 15 2 9	3 2 1 3	3
4	2 2 20	9 1 11	16 0 8	1 2 3 2	1 9 1 24	1 16 0 18	2 2 3 12	2 9 2 6	2 16 1 0	3 2 3 22	4
5	3 1 11	10 0 5	16 2 27	1 3 1 21	1 10 0 15	1 16 3 9	2 3 2 3	2 10 0 25	2 16 3 19	3 3 2 13	5
6	4 0 2	10 2 24	17 1 18	1 4 0 12	1 10 3 6	1 17 2 0	2 4 0 22	2 10 3 16	2 17 2 10	3 4 1 4	6
7	4 2 21	11 1 15	18 0 9	1 4 3 3	1 11 1 25	1 18 0 19	2 4 3 13	2 11 2 7	2 18 1 1	3 4 3 23	7
8	5 1 12	12 0 6	18 3 0	1 5 1 22	1 12 0 16	1 18 3 10	2 5 2 4	2 12 0 26	2 18 3 20	3 5 2 14	8
9	6 0 3	12 2 25	19 1 19	1 6 0 13	1 12 3 7	1 19 2 1	2 6 0 23	2 12 3 17	2 19 2 11	3 6 1 5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6.25	12·5	18·75	25	1 3·25	1 9·5	1 15·75	1 22	2 0·25	2 6·5	2 12·75	2 19	

Weights of Lengths of Rolled Steel Sections.

Beam 16 in. × 6 in. × 75 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 6 3 24	6 13 3 20	10 0 3 16	13 7 3 12	16 14 3 8	20 1 3 4	23 8 3 0	26 15 2 24	30 2 2 20	0
10	0 6 2 22	3 13 2 18	7 0 2 14	10 7 2 10	13 14 2 6	17 1 2 2	20 8 1 26	23 15 1 22	27 2 1 18	30 9 1 14	10
20	0 13 1 16	4 0 1 12	7 7 1 8	10 14 1 4	14 1 1 0	17 8 0 24	20 15 0 20	24 2 0 16	27 9 0 12	30 16 0 8	20
30	1 0 0 10	4 7 0 6	7 14 0 2	11 0 3 26	14 7 3 22	17 14 3 18	21 1 3 14	24 8 3 10	27 15 3 16	31 2 3 2	30
40	1 6 3 4	4 13 3 0	8 0 2 24	11 7 2 20	14 14 2 16	18 1 2 12	21 8 2 8	24 15 2 4	28 2 2 0	31 9 1 24	40
50	1 13 1 26	5 0 1 22	8 7 1 18	11 14 1 14	15 1 1 10	18 8 1 6	21 15 1 2	25 2 0 26	28 9 0 22	31 16 0 18	50
60	2 0 0 20	5 7 0 16	8 14 0 12	12 1 0 8	15 8 0 4	18 15 0 0	22 1 3 24	25 8 3 20	28 15 3 16	32 2 3 12	60
70	2 6 3 14	5 13 3 10	9 0 3 6	12 7 3 2	15 14 2 26	19 1 2 22	22 8 2 18	25 15 2 14	29 2 2 10	32 9 2 6	70
80	2 13 2 8	6 0 2 4	9 7 2 0	12 14 1 24	16 1 1 20	19 8 1 16	22 15 1 12	26 2 1 8	29 9 1 4	32 16 1 0	80
90	3 0 1 2	6 7 0 26	9 14 0 22	13 1 0 18	16 8 0 14	19 15 1 10	23 2 0 6	26 9 0 2	29 15 3 26	33 2 3 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	33 9 2 16	66 19 1 4	100 8 3 20	133 18 2 8	167 8 2 24	200 17 3 12	234 7 2 0	267 17 0 16	301 6 3 24	334 16 1 20	

Compiled and Arranged by T. E. Woodhouse

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

Fuels.

In dealing with fuels, the author proposes to limit his remarks to such points as apply to those fuels when used on vehicles to furnish producer gas. The chief fuel is anthracite, and if this can be readily and cheaply obtained it is advisable to use it. Anthracite can be got in many sizes or grades. That which is required for the small producers used on vehicles is termed "beans" and passes through a $\frac{3}{8}$ in. or $\frac{7}{8}$ in. mesh. It should invariably be sieved before use in order to eliminate any dust. If bought in truck lots from a colliery, it will be received washed and screened ready for use. Anthracite is not generally stocked by local coal merchants, and the author has several times had a mixture of bituminous coal of all sizes, from dust to that of a brick, delivered in lieu. A cubic foot of anthracite weighs from 90 lb. to 102 lb. according to the specific gravity. A cubic foot, if broken up to the size of "beans," weighs approximately 58 lb. A cubic foot of petrol weighs approximately 48 lb. In a given space, therefore, 20 per cent more weight of anthracite than of petrol can be carried.

If the consumption of anthracite is taken as 20 per cent more by weight than petrol, the space occupied by fuel for any given distance would be equal, but the weight of coal would be greater.

Good anthracite should have a calorific value of 15,000 to 15,500 B.Th.U.'s per pound and should consist of carbon 90 per cent to 93 per cent; hydrogen 4 per cent to 4·5 per cent; oxygen 3 per cent to 5·5 per cent, as against petrol, 85·2 per cent carbon and 14·7 per cent hydrogen, and a value of 18,500 B.Th.U.'s per pound. The best depth of fire bed in the author's producer, for anthracite, is 6 in. Anthracite is clean to handle, safe to store, gives off no dangerous vapours, and being very smooth in surface, works well down chutes or fuel pipes from the hopper to the producer.

Coke.

Gas coke, while quite suitable for vehicle work, is more bulky than anthracite. It has already been subjected to one distillation, and, therefore, any volatile constituents left in it are hard to deal with. The composition of the fuel also depends on the class of coal from which it is produced and the treatment to which it has been subjected. It is by no means such a clean fuel in use as anthracite. The sulphur content is over twice that of anthracite, and for vehicle work, where a dry scrubber alone is possible, this is a drawback. The ash percentage also is over double that of anthracite, 5·8 as compared to 2·2, and the calorific value is 13,500 B.Th.U.'s. The ordinary analysis gives carbon, 88 per cent; hydrogen, 0·02 per cent; oxygen up to 3 per cent. The weight of a cubic foot of broken coke is approximately 34 lb. The space occupied is, therefore, large in proportion to anthracite, especially in view of its lower calorific value. It is, however, a fuel which is readily obtainable and is usually cheaper than anthracite; it can be bought broken and screened to the size required; it is clean to handle and safe to store, but owing to its rough surface, it does not feed so well as anthracite.

In working with coke, a larger quantity of water is required per pound of fuel than with anthracite, and this is readily obtained in the author's system by altering the stroke of the water pump and the setting of the steam throttle. It is possible to use coke without this alteration, but as it only takes two to three minutes and gives much better results, it is worth doing. The best depth of fuel bed is 7 in.

Charcoal.

Charcoal is a very suitable fuel for vehicle work. Apart from its light weight per cubic foot, which is approximately 17 lb. to 18 lb., and the large space occupied compared to petrol to cover a similar distance, it has practically no drawbacks. The calorific value is approximately 14,000 B.Th.U.'s It should be broken to the same size as anthracite. It is possible to get away very quickly by using charcoal, a start from cold having been made in 10 minutes. The ash is very light and iiable to be drawn over into the scrubber, so that if this fuel is to be used exclusively, either a large filter box must be fitted, or the scrubber must be cleaned out at shorter intervals. It has a very wide distribution and is often available in districts where coal and oil are unobtainable. With this fuel, a thinner firebed is required, the best results having been obtained when the depth was maintained at 4 in. With light fuels, such as charcoal, the range of the vehicle would be reduced considerably as compared with petrol, owing to the large bulk occupied by the fuel, but no difficulty should be experienced in having fuel stations along the roads, and these would only have to be utilised for long journeys. A 3 ton vehicle should run on 3 lb. of charcoal per mile, so that one cubic foot would run six miles. Six or eight cubic feet could be readily carried on such a vehicle, so that a range of 40 to 50 miles could be covered on one fill-up.

Peat.

Peat did not at first appear to be a very suitable fuel for vehicle work, and the first trials, which were made with ordinary dried peat, which contained 64 per cent of volatile constituents, were not satisfactory. This percentage was quite beyond the capabilities of the plant and effectually tarred up the engine after only a short run. When, however, compressed and dried peat was used, the results given were extremely good and exceeded those given by either charcoal or coke. The peat is compressed into briquettes and afterwards dried to drive off the moisture and troublesome volatile matter. The result is a fuel which is eminently suitable for producer work, especially on motor vehicles, as it enables a rapid start to be made and gives an extremely clean gas of high calorific value and needing little scrubbing.

When broken into suitable sizes, the weight per cubic foot is approximately 47 lb. The dried peat breaks readily into suitable sizes and is not friable, so loss from dust is negligible. One peculiarity with this fuel is the shallow fuel bed required, a depth of 2 in. to 3 in. giving the best results, though satisfactory running has been obtained with a bed only $1\frac{1}{2}$ in. thick.

The producer for this fuel could, therefore, be of very small dimensions, but the ordinary size of anthracite producer has so far been used. Peat has a wide distribution, and its satisfactory adoption must be of enormous assistance in spreading the use of the internal-combustion motor vehicle, especially for agricultural work. The author was informed that the fuel could be supplied at approximately 16s. per ton. If this is so, it would be equivalent to petrol at little over 1d. per gallon.

The peat fire will remain alight many hours ready for an almost immediate start, while starting from all cold can be accomplished in from seven to ten minutes. The author is convinced that satisfactory use of this fuel is only possible by his system of a thin, constantly agitated fire, constant feed, and control of the air and steam supply.

Maize Cobs.

Maize cobs are the centres or stems of the maize after the grains have been removed. Through the kindness of a friend in the Argentine, the author received a small supply of this material, and tests show it to be a very suitable fuel. Owing to its shape, it is easily broken into suitable sizes and is then very easy to feed.

Straw.

It has been calculated that the straw destroyed or worked back into the ground annually in Western Canada alone would, if used in producer gas plants, give an equivalent of 470,000,000 gallons of petrol.

Other fuels will, no doubt, be found, which are quite suitable for vehicle propulsion, but enough has been said to show how much the fuel field has been widened by the use of a gas producer adapted to motor vehicle work. All the above fuels cannot be cornered or juggled with financially, and as they can all be used without any trouble or drawback in producer gas plants, the motor industry need not be entirely in the hands of the liquid fuel ring any longer.

In conclusion, the author desires to thank the Army Council and the Ministry of Munitions Inventions Department for the facilities granted for completing his experiments.

He has dealt with the application of his plant to motor vehicle work, but it will readily be understood that this only represents a very small portion of the possible field of application.

(*Concluded.*)

RAILWAY CONSTRUCTION IN PERU.

It is reported that the construction of new railways has now been approved by the Peruvian Government, and it is likely that some 996 kilometres of track will be laid down in the near future.

His Majesty's Commercial Secretary at Lima has telegraphed to the Department of Overseas Trade requesting that United Kingdom manufacturers of locomotives, rolling stock, and rails, who may be interested in the supply of the required material, should immediately furnish him with copies of their catalogues, for transmission to the Peruvian Railway Bureau, Ministry of Public Works, Lima.

ECONOMIES IN THE GENERATION AND USE OF STEAM.

By Sidney F. Walker, R.N., M.I.E.E., M.I.M.E.

(Continued from page 251.)

Delivering the Fuel to the Boiler Furnaces.

In the earlier arrangements for using powdered fuel, the coal was conveyed from the pulveriser to the hoppers just outside of each furnace by archimedean screw conveyors, and the powder was delivered into the furnace, in some cases by a fan, and in other cases by a revolving brush. In the latest form of apparatus the whole arrangement is carried out by means of air currents, the pressure of the air being below that of the atmosphere, so that there shall be no tendency for the powdered fuel to leak out into the boiler room. The powdered fuel is delivered to a powdered coal bin, from which it passes into a powdered coal main, through a fan specially arranged for the purpose, and working by induced draught; the fan sucks the powdered coal down from the bin and carries it forward into the coal main, mixed with a small quantity of air, the percentage of fuel to the air is too small, it is claimed, for the mixture to be explosive, and the volume of air is sufficient to carry the powdered coal in suspension; as the writer understands it, the particles of coal float in the air current and are carried forward. The powdered fuel main is arranged on the ring main principle, a return pipe leads to one of the collectors that receives the powdered fuel from the pulveriser and the separator, the powdered coal that has not been used returning in this way to the powdered coal bin. The powdered coal main is treated in very much the same manner as a steam main; branches are taken from it to each boiler furnace, valves being placed at the entrance to each branch by means of which the air draught, and with it the powdered coal supply, can be increased or decreased at will. It is only a step from that to regulating the entrance of the powdered fuel to each furnace, or each combustion chamber, automatically in accordance with the requirements of the load on the steam engines or turbines taking steam from that battery of boilers

As mentioned in an earlier part of the article, it appears to the writer that an extension of the air current carrying the powdered coal could be applied to bring the small coal, dust, &c., from the mine workings to the surface, and to transport them to the pulverising station.

The Use of Coke for Firing Boilers.

Another suggestion for economy in raising steam that has recently been made by the London Coke Committee, is that coke should be employed, either altogether in place of coal, or as a diluent. It is claimed that, with coke firing, evaporations of 9 lbs. of water per lb. of coke consumed have been obtained, and that from 15 per cent to 18 per cent of CO_2 in the flue gases has also been obtained. A test was made by the London Hydraulic Power Co., the figures of which are given. The boiler was a Babcock and Wilcox, with the usual chain-grate stoker, and an economiser and superheater; the capacity of the boiler being 6,000 lbs. per hour. It is claimed that the test was very carefully made, the feed water being measured by volume, and the temperature of the feed water and the flue gases being taken every 15 minutes. The test was made with a mixture of coal and coke, against coal only. The calorific value of the mixture is given as a little over 11,000 B.Th.U., and that of the coal only a little over 12,000; it will be noted that the coal was not of very good quality: probably the introduction of the mechanical stoker, which has led to the use of inferior fuels, was the cause. The ash and clinker with the coal and coke was 16·22 per cent, and with the coal only 12·7 per cent, the steam pressure and the superheat temperature were about the same; the water evaporated from and at 212 deg. Fah., was 7·44 lb. with coal only, and 9·22 lb. with coal and coke. An efficiency of 79·96 per cent is claimed for the coal and coke, with the economiser, and of 60·98 per cent for the coal only.

It is pointed out by the London Coke Committee that bituminous steam coal contains only in the neighbourhood of 50 per cent of fixed carbon, the remainder being volatile matter and ash; and they point out further that when bituminous coal is used in a boiler furnace, a process of distillation goes on in the fuel, before actual combustion can take place, with the result that a certain proportion of the carburetted hydrogen gases that are present in the coal are carried off with the flue gases unburnt, and that this leads to the deposit of soot at various parts of the system, the soot building up thermal resistances between the hot gases and the water or steam; and, in addition, that the heat absorbed by the volatile matter in passing from the solid or liquid state, in which it must be carried in the coal, is also taken from the quantity of heat liberated by the combustion of the useful part of the coal, the carbon. Some of the volatile matter, the carburetted hydrogen gas, is further split up into its components carbon and hydrogen, these combining with the oxygen present, and liberating heat; but a considerable portion of the gases escapes unburnt. It will be remembered that in towns' gas works the coal is heated in closed retorts, the heat being applied externally to the retorts, and in modern plant the whole of the volatile matter is driven off, the residue being nearly pure carbon; the London Coke Committee claim that it contains, from 80 per cent to 90 per cent of carbon. They suggest that it should be more economical to treat the coal this way, in the gas works, and to use the residue for firing boilers, than to use the coal directly in the boiler furnace. They state that a number of power plants are being worked satisfactorily with gas coke alone; but, apparently as a concession, they suggest the use of the mixture of coal and coke mentioned above. To enable this to be done, the hoppers of mechanical stokers are divided into two compartments by means of a diaphragm; the coal is fed on to the chain-grate stoker, for which the arrangement appears to have been specially designed, in front of the coke. In another arrangement, there are two diaphragms in the hopper, dividing it into three compartments; coal is fed into the front and back compartments, coke into the middle one. The reason for this latter arrangement appears to be the fire brick arch above the furnace requires a certain amount of volatile gas to be burnt with the coke, in order to maintain it at incandescent temperature. Those who have used coke for domestic fires will remember that one of the features of a coke fire is the complete absence of the dancing flames that are so much liked by Englishmen, and apparently by Americans also, all over the world; the dancing flames are due to the burning of the volatile gases.

A table given by the London Coke Committee for domestic fires is instructive. The heat escaping in the flue gases to the chimney is given as 7·4 per cent more with a coke fire than with a coal fire; the heat lost in ashes and in the grate is given at 0·5 per cent more; but the radiant heat is claimed to be 25 per cent more with a coke fire than with a coal fire, and this 25 per cent is apparently furnished by the absence of loss of heat in unburnt matter, in smoke, escaping up the chimney

(*To be continued.*)

POWER CONDENSOR CALCULATIONS.

By. G. W. Stubbings.

The importance of the influence of power factor on alternating-current supply has been brought prominently before all engineers interested in the use of electricity for industrial purposes by numerous articles in the technical press, and the need for attention to this matter is being brought home still more forcibly by the rapidly increasing practice of offering tariffs for electrical power according to which the price per unit depends, in some way, upon the power factor of the load. This procedure is strictly equitable, and is a necessary consequence of the inherently low power factor of the induction motor, and of the evil effects of wattless c rrents in alternating-current generation and distribution. The improvement of power factor is thus pass'ng from being a subject of little more than academic interest to power users to being one of vital importance.

It is not the purpose of the writer to describe at length the standard methods by which the power factor of a load can be improved. These methods are now generally known, and references to recent articles in the technical press will give all information required. One of the most promising and widely adaptable of these methods consists in the use of static condensers. This method possesses the important advantages of introducing into the power installation no additional moving machinery, as is the case when rotary converters are used, and of making use of apparatus of the highest efficiency and reliability. In spite of the relatively high capital cost of power condensers at the present time, the lack of maintenance charges will usually make the installation of this apparatus an attractive proposition to power users whose load has a low power factor, and where the charges for electrical energy are affected thereby.

Condensers for power purposes are manufactured by the British Insulated and Helsby Cables Co., and this firm publish full directions for determining the size of condenser required for any given conditions by means of curves and formulæ. Many engineers, however, whose training in alternating-current calculations has been none too thorough, or whose acquaintance with this subject has become somewhat rusty, may yet feel that wholesome repugnance towards using a formula whose rational basis they do not completely grasp. For this reason it may be of interest briefly to indicate the lines on which calculations relating to power condensers are carried out, starting from first principles. The calculation of the size of condenser required for given conditions is an important matter where an estimate is being prepared, and even if a formula or curve is to hand, the ability to check the figures from basic principles is very useful.

The fundamental theorem regarding condensers in alternating-current circuits is one of the greatest simplicity. If V be the applied voltage, n the frequency of supply, C the capacity of the condenser, then the current into the condenser is given by the equation

$$I = 2\pi n \, CV$$

and this current leads the voltage by 90°. Proofs of this thorem, more or less convincing, though rigorously exact mathematically, are to be found in all text books on alternating-current theory. To obtain the firm mental grasp of the equation necessary if it is to be remembered, it may be noted that the equation is similar to that expressing Ohms law, in that the quantity $\frac{1}{2\pi n \, C}$ corresponds to a resistance, or, in other words, $2\pi n C$ corresponds to a conductivity. The conductivity, or admittance of a condenser, then, is equal to the product of the capacity into 2π times the frequency, the appearance of 2π in the latter term corresponding to the conversion of an angular velocity expressed in revolutions, into radians per second. The rational reason for this relationship is not hard to grasp. It is fairly obvious that the current into a condenser will be proportional to its capacity, and, since this current is equal to the rate of change of the quantity of electricity in the condenser, the current will increase as the number of charges and discharges per second is increased, and will diminish as these alternations diminish in frequency, till at a frequency of zero, or with a direct current, the current will also be zero, whatever be the voltage or capacity. The unit of capacity corresponding to the electrical units, ampere and volt, is the farad. This unit is, however, found too large for practical purposes, the commercial unit being the micro-farad, which is equal to one-millionth of a farad. The fundamental equation then becomes, if the capacity is expressed as K in micro-farads,

$$I = 2\pi n \, KV \times 10^{-6}$$

An excellent exposition of elementary theory bearing on this matter is contained in Dr. C. V. Drysdale's work entitled. *The Foundations of Alternating-current Theory*, and this book can be recommended to all power engineers desiring a thorough grasp of the subject, without the necessity of wading through an elaborate mathematical analysis.

Bad power factor in industrial electricity supply is caused by the current lagging behind the voltage, this lag being due to the magnetising current of induction motors. Calculations on this matter are most easily performed by considering that any alternating current can be resolved into two components at right angles, the one component being in phase with the voltage and being designated the power component, and the other at right angles to the voltage, being incompetent to produce any power in the circuit, and consequently designated the wattless component. In the diagram Fig. 1, OV is the voltage vector, OI the current vector, lagging the voltage by an angle ϕ. This current being resolved into two components, OI_P in phase with the voltage, and OI_W in quadrature. Of these components OI_P is the only one that produces power, and this power is seen to be $VI_P = VI \cos\phi$, $\cos\phi$ being the power factor. The wattless component OI_W is the cause of the low power factor, and of all the attendant disadvantages. The interposition of a condenser into the circuit causes the flow of a wattless current leading the voltage by 90°, as represented in the diagram by I_K. It is easily seen

that the two wattless currents, the one supplying the induction motors, and the other flowing into the condenser, are opposed in direction by 180°, and consequently can be added or subtracted arithmetically. In the circuit under discussion the resultant wattless current will be the difference of the two currents OI_W, and OI_K, and this is represented by OI'_W. The actual current in the circuit will be equal to the resultant of OI'_W, and the unaltered power current OI_P, and is shown by OI', the angle of lag having been reduced to ϕ'. Had the leading current into the condenser been exactly equal to the lagging current of the induction motors, the resultant wattless current would have been zero, and the actual current would have been in phase with voltage, and the power factor equal to unity.

A simple numerical example will best explain the method of calculating the size of condenser required for given conditions. Let it be desired to determine the capacity of the condenser required to raise the power factor of a load of 200 K.W. from 0·8 to unity, the voltage being 400, and the frequency 50. Using the same symbols as before, and retaining the usual *cos* ϕ for the power factor, we have

$$I = \frac{K.W. \times 1{,}000}{V \times \cos\phi} = \frac{200 \times 1{,}000}{400 \times 0{\cdot}8} = 625 \text{ amps.}$$

Power component of this current, $I_P = I\cos\phi = 625 \times 0{\cdot}8 = 500$ amps.

Wattless component of the current, from the geometry of Fig. 1—

$$I_W = \sqrt{I^2 - I_P{}^2} = \sqrt{625^2 - 500^2} = 375 \text{ amps.}$$

In order to raise the power factor to unity, it will be necessary to connect in the power circuit a condenser, which at 400 volts will take a leading current equal to the lagging current of the power load.

From the formula we obtain

$$I = 2\pi \, NKV \times 10^{-6} \text{ amps.}$$

$$K = \frac{I \times 10^6}{2\pi n V} \text{ micro-farads.}$$

Substituting the given values

$$K = \frac{375 \times 10^6}{314 \times 400} = 2{,}980 \text{ micro-farads.}$$

The wattless current in the above example can be calculated more rapidly by the use of a table of trigonometrical functions. From Fig. 1 it is evident that $I_W = I \sin\phi$, and since $\cos\phi$ is the given power factor, the angle ϕ and its sine can at once be found. In the above example, for instance,

$$\cos\phi = 0{\cdot}8$$
$$\phi = 36° \, 55'$$
$$\sin\phi = \sin 36° \, 55' = 0{\cdot}6 \text{ approx.}$$
$$I_W = I\sin\phi = 625 \times 0{\cdot}6 = 375 \text{ amps.}$$

It is well known that it is not, as a rule, economical to raise the power factor to unity, a value of 0·95 being sufficient for most practical purposes. The reason for this will be clear from a numerical example in which the condenser capacity required to increase the power factor to 0·95 in the circumstances of the previous example is determined.

To find the wattless current at 0·95 power factor,

$$\cos\phi' = 0{\cdot}95$$
$$\phi' = 18° \, 12''$$
$$\sin\phi' = 0{\cdot}3123 \text{ from tables.}$$

Wattless component $I'_W = I \sin\phi' = 625 \times {\cdot}3123 =$ 195 amps.

In order to effect the required improvement in power factor from 0·8 to 0·95, it will be necessary to reduce the lagging current from 375 to 195 amps. The leading current required will therefore be 375—195 = 180 amps. The capacity required will therefore be for 180 amps. instead of 375 amps. as in the first example, and this capacity will be—

$$K' = \frac{180 \times 10^6}{314 \times 400} = 1{,}430 \text{ micro-farads.}$$

It is therefore seen that to raise the power factor from 0·8 to 0·95 requires less than one-half the capacity required to bring the power factor to unity. This can also be seen very clearly from the diagram, Fig. 2, in which the horizontal line OI_P is marked as a scale of power factors, the angle of lag and the wattless component being given by erecting a perpendicular from OI_P at the given power factor to cut a circle described with O as centre through the unity mark on the scale. The relatively large wattless current to be cancelled at as high a power factor as 0·95 is very apparent.

Technical considerations regarding the installation of condensers are best obtained from the makers. The purpose of the writer has been to indicate on elementary lines the basic theory of calculations relating to the capacity of condenser required for given conditions, in order that power engineers may be in a position to investigate the commercial benefit of power factor improvement for their own particular case. Regarding the approximate cost of condensers at the present time, reference may be made to an exhaustive article on the subject of power factor improvement by E. W. Dorey in recent issues of the *Electrical Review*. In the course of this article the author stated that the present-day price of static condensers working at pressures between 400 and 500 volts is approximately 5s. per micro-farad exclusive of switchgear; and an estimate of the cost of a condenser of 2,200 micro-farads gave the cost of switchgear as £100. These figures, though approximate, are exceedingly valuable as enabling a good idea of the cost of the condenser for any given conditions to be obtained. In the second numerical example, for instance, the cost of the condenser of 1,430 micro-farads capacity could be taken as £380, and taking the cost of the switchgear at £70, the total cost of the equipment would be of the order £450. The consumption in units per annum of a load of 200 kw., operating 48 hours per week, and 50 weeks per annum, would be 200 × 48 × 50, or 480,000. Assuming it were desired to pay for the condenser equipment in three years, the capital charges would be about £150 per annum, or 0·075d. per unit consumed. It is more than probable that, with a tariff depending upon power factor, the reduced charge per unit consequent upon an improvement from 0·8 to 0·95 would be at least equal to 0·075 per unit. The losses in the condenser have been neglected in this calculation, but these are very small, and may be taken as being equal in kw. to 0·5 per cent of the kilo-volt-ampere capacity. Referring again to the above example, the kva. capacity will be $I'_W \times V = 195 \times 400 = 78$ kva. The loss will accordingly be 78 × 0·5 per cent = 0·39 kw. The loss per annum would be therefore 48 × 50 × 0·39, or, say, 960 units per annum, which at 1d. per unit is equivalent to £4 per annum, a comparatively insignificant amount. This calculation is, of course, based upon the assumption that the condenser would be switched out when the works were shut down, and in practice this would always be done.

HOW TO ORDER GRINDING WHEELS.

Prompt shipment of grinding wheels is possible only when we are able to enter your orders immediately after they are received More delay is caused by failure to put all of the necessary information on the order than by any other one cause. When an order is received without complete information it is necessary for us either to write to you or to search through

figure 1.)

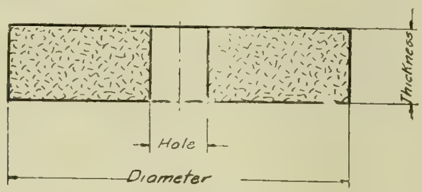


Figure 1

our records to determine whether you have ever had a similar wheel. In most cases we have to write.

Wheels ordered belong to two general classes: those that have been used before and are being reordered and those that are being ordered for the first time.

Reordering.

To fill an order intelligently we must know the size of the wheels required, the shape and face, the grain and grade, abrasive and process. When reordering, if the Norton order number of the last wheels shipped can be given, this is an added check on the specifications and is of a great deal of assistance to us.

Dimensions.

Complete dimensions must always be given. These should always be given in the order, diameter × thickness × hole size. *Straight wheels* need only the three dimensions, such as $16 \times 2 \times 2$ in. (See Fig. 1.)

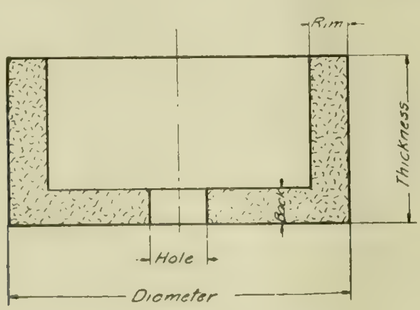


Figure 2

Cup wheels should have in addition the rim and back thickness given; for instance, $4 \times 2 \times \frac{3}{4}$ in., $\frac{1}{2}$ in. rim, $\frac{1}{2}$ in. back. (See Fig. 2.)

If the cup is tapered, the two diameters are given as a fraction, as $(4\text{-}3) \times 2 \times \frac{3}{4}$ in., $\frac{1}{2}$ in. rim $\frac{1}{2}$ in. back. (See Fig. 3.)

Cylinder wheels should have the rim thickness substituted for the hole size, 18×5 in., $1\frac{1}{2}$ in. rim. (See Fig. 4.)

Recessed or countersunk wheels should have the diameter and depth of the recess specified, $18 \times 2 \times 5$ in., countersunk one side $8\frac{1}{2}$ in. × $\frac{1}{2}$ in. (See Fig. 5.)

Shape.

Whenever a shape other than a straight wheel is wanted this must be specified. The common shapes are listed and illustrated in our catalogue. If we receive an order for a wheel $6 \times \frac{1}{2} \times 1\frac{1}{4}$ in., a straight wheel would be shipped. A Norton No. 10 dish wheel has the same specifications, but in addition to the dimensions, Norton shape No. 10 must be

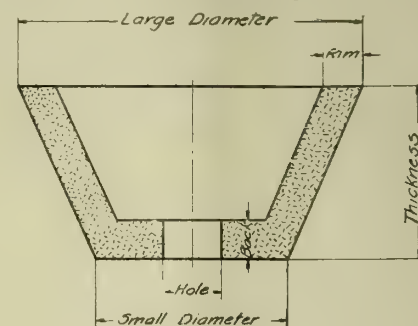


Figure 3

specified if this dish shape is wanted. If you cannot find a wheel of the shape wanted in the catalogue, send a sketch with complete dimensions, as shown in Fig. 6.

When no face is specified a straight A face wheel is furnished. The different faces which are regularly furnished are sepcified by letters as shown.

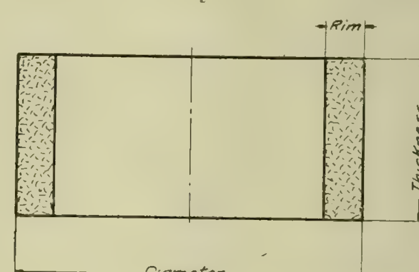


Figure 4

Grain and Grade.

Grain is specified by a number which gives the size of the grain used in the wheel. Number 30 means grain that will pass through a screen having 30 meshes to the linear inch or 900 per square inch.

Grade is the term used to denote the hardness of a

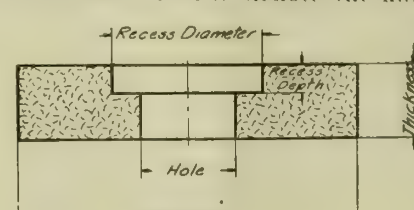


Figure 5

grinding wheel. It actually represents a measure of the strength of the bond or the holding force exercised by the bond to retain the grain in the wheel. For vitrified and silicate wheels it is specified by a letter ranging from the softest wheel F to the hardest Z. For elastic wheels a number is used, grade $\frac{3}{8}$ being the softest and grade 7 the hardest.

A grain 30 grade M wheel is one made of No. 30 grain in grade M hardness.

Abrasive and Process.

We have two kinds of abrasives, Alundum and Crystolon. Alundum is made in three tempers: regular, No. 66 and No. 38. If no mention is made of abrasive we assume that the wheels are to be made of regular Alundum abrasive. If No. 38 and No. 66 Alundum abrasives are wanted, they must be specified (except where we know that these two abrasives give best results). They are specified by the figures 38 or 66 given before the grain size, such as 3830 or 6630.

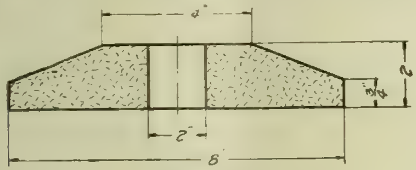


Figure 6

Crystolon must be specified by using the word Crystolon.

Norton wheels are made by four processes: vitrified, silicate, elastic, and rubber. When no process is specified we assume vitrified is desired, unless, of course, the grade is given as a number, when elastic wheels will be furnished. If silicate or rubber wheels are required, this must be specified.

When New Wheels are Ordered.

When ordering wheels for a new operation, be sure to give the size and shape wanted. If in doubt about

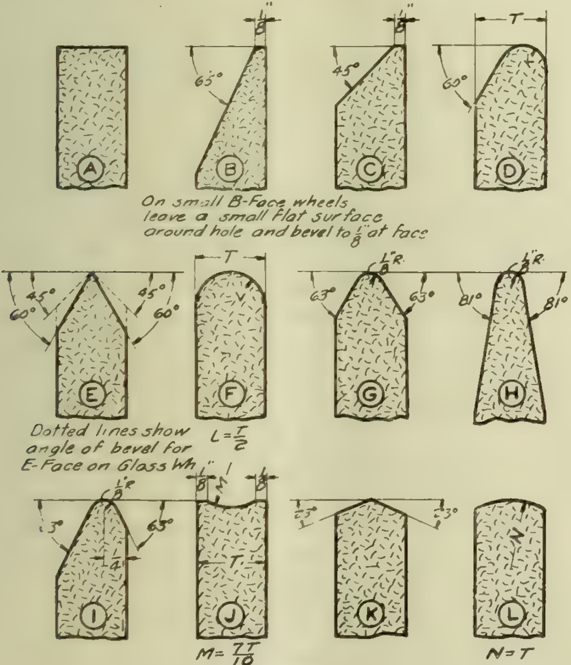


Figure 7

the proper grain, grade, abrasive, and process, allow us to specify. To do this we must know the details about the operation: the shape, size, and kind of material, what the operation is, whether cylindrical, internal, or surface grinding, amount of stock to be removed, the wheel and work speed, whether wet or dry grinding will be employed, finish required, and any other factor that will be of interest to us. Better still, fill out in detail an information blank, which we will be pleased to send to you upon request.

EXACT DATA ON THE PERFORMANCE OF MECHANICAL STOKERS AS APPLIED TO "LANCASHIRE" OR OTHER NARROW-FLUED BOILERS.*

In this paper it is proposed to deal with mechanical firing, and the exact figures obtained by the complete scientific investigation of the working of 80 typical "Lancashire" boiler plants, mechanically fired, will be brought forward for consideration. The firm with whom the author is associated have been engaged for the past 10 years in testing and reorganising steam boiler plants, and the figures in this paper have been obtained during the course of this work.

In order to avoid confusion, this paper has been confined to the results obtained with "Lancashire" boilers—that is, narrow-grate boilers (which would include also "Cornish" boilers, marine boilers, and all similar types of boilers), leaving the consideration of "tubular" boilers that is, wide-grate boilers to a later date. An additional reason why the "Lancashire" boiler has only been considered is because it is essentially the standard boiler of the country to-day. It is difficult to give exact figures on this point because we have no proper engineering census of the country, but it is obvious that by far the greater number of steam boilers at work in Great Britain are of the "Lancashire" type. Thus in the article, "Coal Saving by the Scientific Control of Steam Boiler Plants," already mentioned, 250 steam boiler plants were considered representing 27 different industries. The total number of boilers was 1,000 of which 935 were of the "Lancashire" type, 36 were "tubular," 17 "egg-ended," six "Cornish" boilers, one "marine," two "vertical," and three "patent" boilers.

In certain very large industries of the country, such as collieries, cotton mills, woollen mills, dyeing and bleaching, calico printing, flour milling, paper manufacture, and the chemical industries, almost the only boiler used is the "Lancashire." Tubular boilers are, of course, typical of electric power stations, and found to some extent in steel works and engineering works generally. The question of mechanical firing is, therefore, of much greater interest from the point of view of the present average performance of boiler plants when considered in connection with "Lancashire" boilers, simply because the amount of coal consumed in Great Britain on "Lancashire" boilers is probably 8 to 10 times that on tubular boilers.

Mechanical stokers are of two general types:—

(A)—COKING TYPE.

The first successful stoker of this type was invented by John Juckes in 1841, and consisted of longitudinal firebars connected by links, forming an endless chain. The coal was deposited on this travelling chain from a hopper in front of the boiler, and the fuel gradually burned as the grate travelled forward, discharging ash and clinker over the back. The modern chain-grate stoker for tubular boilers in simply a development of this stoker. In general, coking stokers burn the volatile hydrocarbons of the coal at a different portion of the grate from the fixed carbon—that is, they first "coke" the coal, burning the volatile products driven off by this process, and then burn the coke produced.

In modern types (overfeed) for "Lancashire" boilers, the movement of the coal from the hopper until it drops over the back of the grate as ash is obtained by means of reciprocating bars worked by the stoker drive. A special form of the coking stoker is the "underfeed" type, in which the coal is forced up from underneath the grate (instead of on the top ("overfeed") of the grate as in the ordinary types) by means of a ram or worm conveyor. The grate is really a species of trough in which the volatile matter is burnt on the apex of the pile of burning fuel, and the coke burnt as it travels downwards and sideways through the whole length of the trough or grate. There are several types of such stoker manufactured.

(B)—SPRINKLING TYPE.

The first successful stoker of this type was brought out by E. Henderson in 1843, and consisted essentially of two horizontal fans revolving on vertical spindles, which scattered or sprinkled the coal in small quantities all over the grate so as to imitate hand firing. In modern types of sprinkling stoker, the coal is thrown over the grate by means of a throwing shovel, and the whole length of the grate is utilised for the combustion of the volatile matter and the fixed carbon of the coal at the same time. The firebars have a reciprocating motion to provide for the continuous and automatic removal of clinker and ashes over the back of the grate.

* Abstract of paper read by David Brownlie, B.Sc. (Lond.), F.C.S., of Manchester, Associate, before the Institution of Mechanical Engineers.

There is amongst steam users a very great difference of opinion as to the advantages, or otherwise, of mechanical firing as compared with hand firing. On this question, as on most other questions in connection with coal economy, there are little authentic data available. In general engineering literature, including text-books and reference manuals, most of the scanty information given on the subject is supplied by the makers of mechanical stokers themselves, and this information cannot be regarded as exactly unbiassed in its character. There seems to be a general hazy sort of impression among steam users that mechanical stokers give higher efficiency, and that they are a necessity to the best results, but the chief trouble is wear and tear and cost of upkeep. The Government are evidently of this opinion, and the Coal Control Department, for example, recommends mechanical firing for collieries. As the Department is presumably aware that the vast majority of boilers in collieries are of the "Lancashire" type, it therefore recommends mechanical firing for "Lancashire" boilers. The Department states that mechanical stoking saves labour in the fire hole, that low-grade coal can be burnt more efficiently than with hand firing, and that greater evaporation can be obtained from the boilers. The advantages claimed for mechanical stokers will be dealt with later in detail, as well as all the disadvantages urged by advocates of hand firing.

The author has given the exact figures for the performance of 80 typical plants in Table 14. These 80 plants are not selected cases, either good or bad, but are plants taken at random, according as his firm was instructed to undertake the work by the various owners of the plants. In the author's opinion, although he can give no actual evidence to support it, these 80 plants are typical of the mechanically-fired "Lancashire" boiler plants of the whole country.

The object of the test was to find out the exact normal everyday working conditions of the plant, particularly as regards efficiency, so that a scheme of reorganisation could be devised for the more economical production of steam. In every case the boiler-house staff worked the plant as usual, and at the end of the tests the water level in the boilers and the general conditions of the fires was the same as at the commencement. Taking the various items which require some explanation in detail :—

The fuel was weighed accurately in the usual manner depending on the circumstances of the plant. The greatest care was taken to get thoroughly average samples of the fuel, and the heating value was determined in every case with the oxygen bomb calorimeter direct in the fuel as fired.

With regard to the water evaporated, various methods were used, depending on circumstances, but generally the method adopted was the use of a well-known make of pressure-type hot-water meter calibrated before each test, and working between the boiler-feed pump and the boilers. The old method of weighing the water direct in tanks, which was sometimes used, is, of course, very cumbersome, and almost impossible for regular weekly recording, such as is necessary on a properly organised boiler plant. Some form of water meter is therefore essential. Whichever type is adopted, the author strongly recommends the additional installation of a calibrated tank of, say, 500 gallons to 1,000 gallons capacity, so that the accuracy of the meter in use can be checked at any time.

The feed water was analysed by the Wanklyn soap-test method before and after boiling, giving the permanent and temporary hardness. The temperature of the feed water before and after the economisers, the draught at various points, the temperature of the flue gases before and after the economisers, the steam pressure, and the temperature of the superheated steam were taken every half hour and averaged.

As regards the percentage of CO_2 in the flue gases, a CO_2 recorder was fixed on the plant and the percentage of CO_2 recorded at the rate of about 20 analyses per hour. On the week's trial, the samples of gas were taken from the side flues of each boiler in rotation, allowing as a rule about 12 hours (240 analyses) on each boiler.

With regard to the steam or power used as an auxiliary to the production of steam, in the case of an engine, the indicated horse power of the engine was taken, and from the type of engine used a very good idea was obtained of the steam used. Thus for the ordinary enclosed, forced lubrication, high-speed engine in use for driving forced or induced draught fans, an average figure is 35 lb. of steam per indicated horse power. In the case of a motor drive the power used is, of course, very easily determined. The difficulty is in connection with steam used in the form of steam jets, either under or over the firebars. An apparatus was devised for the purpose of estimating the amount of steam issuing from nozzles, consisting of an enclosed cylinder, connected with a long condensing coil. In determining the steam used, the steam pipe and nozzles, or heavy casting with series of small holes, or other apparatus used, is placed bodily in the enclosed cylinder and coupled up in exactly the same manner as when under the firebars. The steam passes through the cylinder and the coils, which are immersed in cooling water and are open to the air at the end, and the steam used over a period of several hours weighed direct as condensed water. This apparatus is found to be very simple and convenient, and gives absolutely accurate results.

Another final point to be borne in mind, in considering the results, is that the general methods of running steam boiler plants, both hand and mechanically fired, are out of date. A mechanical stoker, like any other mechanical device, has to be used with a certain amount of discretion, and if this is lacking one can hardly blame the mechanical stoker. In considering, therefore, the advantages and disadvantages, the facts with the present general out-of-date methods in vogue have first been stated, and then the facts that would obtain if modern scientific methods of control were adopted.

Detailed analysis of the results of the 80 tests together, with advantages claimed for mechanical firing and the disadvantages urged against it.

(A)—General Analysis.

PLANTS REPRESENTED.

The 80 tests represent the boiler plants of 18 woollen mills, 13 paper mills, 12 explosive factories, 11 dyeworks, five cotton mills, four chemical works, four collieries, four engineering works, two calico printers, two dyeing and cleaning works, two hat works, two hosiery mills, and one general textile mill, and are therefore a good average selection of the mechanically-fired "Lancashire" boiler plants of the country.

As regards the size of the plants, these are quite representative, varying from the largest plant of 16 boilers with an annual coal bill of 79,000 tons down to plants of one boiler with a smallest annual coal bill of 950 tons. The total annual coal consumption on the whole, 80 plants is approximately 715,000 tons, and the total number of boilers 299. The number of different makes of mechanical stoker included in the tests is eight, three being sprinkling and five coking.

PRICE OF COAL USED.

The actual price paid for the coal used on the various plants has not been given, because these figures would be of no interest, as the 80 plants were tested during a considerable number of years, and, of course, the price has varied enormously. At the present moment the average price paid for coal throughout the country will probably be about 30s. The increase in the price of coal during recent years has, of course, been sensational. According to the evidence given before the Coal Inquiry Commission by Mr. A. L. Dickinson, Chairman of Finance Board and Financial Adviser to the Coal Controller, the average value per ton at the pit head of the coal raised for the different years is as follows :—

	s.	d.
1908 1913	8	9
1914	9	11¾
1915	12	5½
1916	15	7¼
1917	16	8¾
1918	24	10

(*To be continued.*)

BOILER PRIMING AND A CURE.

By F. R. Parsons.

What might well be considered to have been an extremely pronounced case of boiler priming has just recently come under the writer's notice. The plant in question comprised a twin set of Lancashire boilers, 30 ft. × 8 ft., having a working pressure of 100 lb. per square inch. They had been installed some 18 or 20 years, but only within the last year or two have they been worked up to anything like their rated output.

Then commenced priming troubles. The boilers supplied the usual forms of prime movers incidental to a paper mill, also steam for heating the various machines. The supply of steam was fairly constant, the boilers were not unduly pressed, inasmuch as natural draught was employed, no grease entered with the feed water, and firing was conducted as intelligently as possible.

The first serious happening resulting from the carrying over of an abnormal proportion of water with the steam was a smashed high-pressure cylinder cover of a 100 H.P. compound Robey-type engine. Moisture tests were made by a M'Innes combined separating and throttling steam calorimeter, in order to ascertain the approximate proportion of water passing with the steam; these being taken direct from the stand pipe, so that the moisture was measured directly the steam left the boiler. The result was amazing; the test showed an average moisture percentage of 18.7.

At the earlist opportunity the writer made an inspection of the boiler, and found that while there were attached to the upper shell plates a pair of lugs, set in such a position and at such a distance apart that obviously they were intended to carry an anti-priming pipe, of the existence of the latter no one connected with the plant had the faintest knowledge whatever. Whether they had been inadvertently omitted by the makers, or whether removed some long time back by one of the previous engineers as of little practical use, was a mystery no one could solve.

However, an anti-priming pipe was forthwith designed and made. It was given an ample length, ten feet something, I think, and was 8 in. internal diameter. This was provided with a tee-piece which extended a little way upwards into the dome opening. Four rows of slots were cast in along the full length of the top of the pipe, the total area of which being about equivalent to the net area of the steam junction valve. The pipe was set not exactly horizontal, but given a slight fall, the lower end of it being provided with a drain hole, in order that any water collected therein should clear itself away and fall back into the boiler.

An eight hours' evaporative test was then conducted, and calorimeter measurements of the moisture passing with the steam were taken every hour. These varied from 0.87 per cent to 1.75 per cent; the mean being recorded as 1.23 per cent.

FOREIGN TRADE POSSIBILITIES.

COMMERCIAL ADVERTISING IN THE ARGENTINE REPUBLIC.

The following is part of a report which has been received by the Department of Overseas Trade from His Majesty's Consul-General at Buenos Aires (Mr. H. G. Mackie) on the subject of commercial advertising in the Argentine Republic :—

"I am of opinion that no good results would be obtained by advertising in the Argentine Republic on the part of British manufacturers and exporters unless they possess local representation, for the simple reason that whatever interest might be created by these means it could not be followed up immediately. On the other hand, such firms as have local agencies should request their representatives (if they have not already done so) to send a complete detailed report on the best ways and means of increasing their trade here whether by advertising in the various newspapers and journals, or by a more extensive propaganda, according to circumstances and the nature of the articles they manufacture.

"Those articles which can be classified under various trades, such as building materials, sanitary ware, machinery in general, articles for furniture and cabinet-makers, machinery for the various factories, mills, waterworks, gas and electric light companies, freezing establishments, tanneries, sugar factories, railways, Government Departments, etc., I am of opinion can only be put on this market by a representative always keeping in personal contact with such concerns, whether orders are placed with local houses, or at home, or through the representative on the spot. Generally speaking, Buenos Aires is the great distributing centre for the Argentine Republic, and as nearly all these concerns have their offices in Buenos Aires, the representative can without difficulty make periodical calls and so keep in close contact with them. In such cases it is a question whether advertising to any great extent would be necessary, seeing that the representative would devote his whole time and attention to making these periodical calls. For example, if a representative is selling cast-iron pipes, steel pipes, copper tubes, etc., it would be his work to become acquainted with and to cultivate the friendship of the various buyers, such as the Government Departments, railways, waterworks, gas companies, factories, etc., and the more time he could give to calling upon them the greater would be the results.

"There have been cases where British and American representatives, in their endeavour to put unfamiliar articles on this market, have sold to the principal importers, to the smaller shops, and even to consumers at the same time. The sequel to such transactions on the part of the representative is that smaller firms, having bought more than they needed, and in order to meet their bills on due date were obliged to sell below current prices, and this naturally has been detrimental to bona-fide importers. Now the principal importers in some lines are determined to put a stop to this and have decided to ask representatives to sell to them alone, otherwise they would refuse to do any further business with them. There are some representatives here who, finding it difficult to get the principal importers to take up their goods at first, have started to sell to the smaller people until these goods have become known, with the idea of forcing the principal importers to buy from them later on. This I realise is necessary, but it is advisable, once the importers are interested, to give up the smaller people and to treat with the principal importers only, and for the latter to sell to the other firms.

"Another point which I should like to mention is that many of the firms who are now getting into the Argentine are not able to sell under their principals' trade marks, as the leading importers realise now that it does not suit them to sell better-class goods except under their own marks. Before then it was possible for foreign firms to establish their own trade marks here, and the importers merely added their trade marks to goods of inferior quality of local make or cheaper imported grades. Now, it is their wish to get their own trade marks accredited for high-class articles. The representatives who are obliged to accept orders for goods under the trade marks of their customers may find it somewhat difficult to advertise their firms' specialities, but I think this difficulty might be overcome by their combining with their customers and making allowances to them for advertising and assisting them in the propaganda work."

In connection with this report I may add that United Kingdom firms will find much useful information in a memorandum on commercial advertising compiled by His Majesty's Commercial Secretary at Buenos Aires, copies of which can be obtained on application to the Latin America section of this Department.

AGENCIES IN HOLLAND.

There can be no doubt that British trade in Holland has in the past suffered in comparison to the progress made by Germany. This can, of course, be in a great measure attributed to the geographical position of Holland and to the similarity of the Dutch and German languages, rendering it possible for a German firm to "cover" Holland with their travellers almost as if it were a German Province. The consequence was that the smallest buyers in the most out of the way towns were regularly visited by German travellers, while they were in many cases entirely ignorant that the goods which they dealt in were manufactured in the United Kingdom at all Furthermore, German goods were made to suit the market and put up in packages with Dutch lettering and where necessary Dutch directions for use, details which were ordinarily ignored by British firms.

In many lines, too, business is lost to the United Kingdom owing to lack of stocks in this country. Take, for instance, steel and hemp hawsers and ships' paint : a tug boat may break a tow line or a ship may need a coat of point : in many instances British hawsers or paint could only be obtained by ordering from the United Kingdom, and the order is therefore filled by a perhaps inferior article of German make, simply because it is available for delivery from stock.

Many British firms with business relations of old standing with Holland are not represented here, but content themselves with

sending a representative once or twice a year to book orders. The best comment on this is a reply actually given by a local firm to one of these travellers who was making his half-yearly round to book orders : "Sir, the chances against my wanting something on the day of your visit are something like 180 to 1."

Representation therefore can, I think, be summarised in the following scale, arranged in order of merit :—

1. Branch office in Holland with or without stocks according to circumstances.
2. Resident British representative.
3. Agency entrusted to British merchant firm established in Holland.
4. Agency entrusted to Dutch firm.
5. No local representation, traveller making periodical visits.

Nos. 1 and 2 are, of course, beyond the means of many firms, but the suggestion has been made that several manufacturers of cognate but non-competing articles might establish a selling agency in common on one or other of these bases.

It is considered, above all, important that no British firm should appoint a local agent without first sending a responsible member of the firm to examine local conditions, ascertain the type of article most in use, and make careful enquiries as to the capacity of the agent to cover the district entrusted to him and as to other and possibly competing agencies held. Incidentally, it would be well not to ignore the question of a language thoroughly understood by both parties. Cases have come to my notice of serious difficulties and misunderstandings arising, simply owing to the fact that the Dutch agent, while professing a good knowledge of English and possibly speaking it moderately, could not express himself intelligently in his letters to his British principals nor gather the correct meaning of their communications.

As regards the class of agent coming under headings three and four—*i.e.*, whether buying on own account or working on a commission basis, much depends on the nature of the goods and the wishes of the principals. On the whole, I am inclined to favour a Commission agent, provided he is energetic, sufficiently in a position to cover his district, and helped by advertisement.

The whole question of advertisement in Holland is one which would repay further study by experts, as the conditions, both material and psychological, are very different to those obtaining in the United Kingdom, and the opportunities are large, the art of advertisement here not having by any means reached the standard of Great Britain and America.

MECHANICAL IDEA.

Honour is always rightfully paid to the originator of a new conception; sometimes, like virtue, the credit of invention is its only reward and nothing tangible follows. The student of the history of mechanism finds instance after instance where only at long last did the innovator get even the credit his due; more often like the pioneer of thought everywhere else, he met with contumely and reproach. The evident facts should serve to keep in check any extravagant expectations on the part of those who assist mechanical evolution along its detail path.

The original conception may be crude, far-fetched, or wild, but vision is not bestowed generally, or at least, not that far sight which skips the intervening years, avoids the long practical patient disentanglement and experiment needed, and sees only the possibilities open to human activity. Most of us are so constituted that our attention is devoted wholly to the matter in hand, and while speculation must obviously be visionary, it is no use to dismiss it as a mere chimera, the product of a dream, and pass on. Unless the tasks in hours of insight willed had been first half caught the fact that they may be through hours of gloom fulfilled would be lost. It is necessary to have a goal to provide the incentive to the struggle. Curiously enough, the man who has the vision splendid rarely has the type of mental equipment necessary to shape it into practical form; hence the opposed natures of inventor and engineer. The combination of both faculties is dangerously near to genius.

Descending to a lower plane, the man who never has a new idea is all too common, and it is little recognised how much of this is due to lack of external stimulus. To provide such stimulation is the end and aim of all suggestion systems, methods of reward proportionate to effort, patent protection, and the opportunity to rise to superior position. The average man, skilled and trained, who has intelligence and some amount of talent, becomes possessed of a new mechanical idea; it may be very humble in character, quite insignificant in the mass total of mechanical effort; dependent upon his temperament he may consider it something extraordinary or beneath notice.

No new idea, whether fundamental conception or improvement of the most trivial detail, is, or can be, held despicable. The wild ideas of value held by some individuals need correction, and all new ideas need to be sifted and matured.

Unless all help, the progress of mechanical evolution is retarded; unless all assist, the betterment of product cannot be made.

Most men have a fear that anything which suggests itself will not meet with sympathetic understanding, and that most precious thing, the first clear conception of improvement, if damped retards the individual himself. Whatever has been the case in the past, it is quite certain that an alteration in this respect will be one of the new features of industry. The suggestion box having admittedly failed, there is room for some new method to select current shop ideas. Would it, for instance, be possible to ask each man individually, tactfully, and with some confidence established what idea he has to contribute to the common welfare, or to the methods, processes, or conditions prevailing in the shop? It is admitted that the task might prove difficult, but every man knows the shop critic whose views upon cross-examination might contain a germ for cultivation. There is room for co-operation in industry; proof of value should naturally carry commensurate reward, but even this is not absolutely essential, although it is the wiser plan.

Finally, there is the definite medium always open of the columns of the technical press, whose chief function, besides its chronicle of current practice, is to give publicity to new idea. The glittering thought may turn out to be old practice; the marvellous scheme find precedents of past failure; in any event, stating a case clarifies the thought in the mind of the originator, and this in itself is worth while.

As a suggestion box the technical journal is unique; all suggestions are paid whatever their intrinsic merit, while no editor can afford to turn down anything having the germ of promise.

The Dutch East Indian Fair. An Industrial Fair will be held at Bandoegn, Dutch East Indies, during the course of May next. It will be coincident with the Pan-Pacific Congress of Engineers which will be held at Weltevreden. The Fair will be open for 15 days at least, and goods of all kinds will be exhibited, and will be divided into three sections comprising eight groups. Samples of products and manufactures not of native origin will form the 1st section, and in the 2nd, there will be exhibited goods of purely native origin, whilst the 3rd section will comprise articles of which no samples have been submitted in either of the 1st or 2nd sections.

Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

FURNACES.

126,547.—A. Hofmann, 80, Asylstrasse, Zurich, Switzerland.—Aug. 15th, 1918.—Two or more travelling grates having transverse bars with their free edges in step form are arranged one above the other so that each lower grate receives the fuel from the one above it, all the grates being adapted to allow air freely to pass through them. The lower grates are preferably driven at lower speeds than the higher. The installation shown comprises a fuel hopper 1 with a feed conveyer 2, an upper inclined chain grate 5, a lower horizontal one 6, and an ash conveyer 35. An adjustable flap 4 regulates the thickness of the fuel layer on the grate 5, and a seal 7 consisting of hanging flaps prevents undue admission of air at the end of the grate 6. The side plates of the furnace above the grate level may be air or water-cooled. All the moving parts are driven from

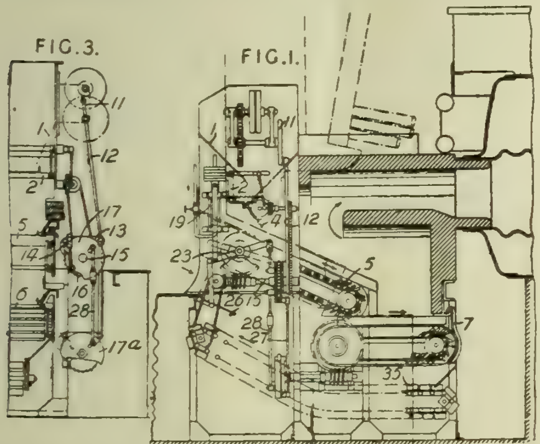


FIG. 3. FIG. 1.

a crank-disc 11 by a rod 12 which actuates the pawl 14 of a ratchet-wheel 16 on the shaft 15. This shaft drives the grate 5 by means of a worm and worm-wheel and also actuates the feed and ash conveyers 2 and 35 by means of gearing. The lower grate is driven, preferably at a reduced speed, by worm and ratchet gearing actuated by a rod 27 connected to the lever 13 of the pawl 14. The speed of the mechanism is controlled by the boiler pressure through a piston in a cylinder 19, which actuates, through a lever 23 and links, a mask 17 which varies the effective stroke of the ratchet pawl 14. A similar mask 17*a* is provided on the driving gearing of the lower grate, and the two are connected to move together by a rod 28, adjustable in length so that the relative speeds of the two grates may be varied. The lever 23 also actuates a damper 26 controlling the air supply to the grate. In a modified form with three travelling grates, the second and third are upwardly inclined at a slight angle, and the third is driven in the reverse direction to the first and second.

JOINT-MAKING PACKING.

126,914.—Schneider and Cie, 42, Rue d'Anjou, Paris, Dec. 10th, 1918.—In expanding and stressing a gun or other tubular article by internal hydraulic pressure, a pocket F, Fig. 5, is formed behind the cup packing D. In order to prevent tearing of the packing, it is supported by a bevelled split ring E which rides on a similarly bevelled split or solid ring H. The packing D, which may be of

FIG. 5.

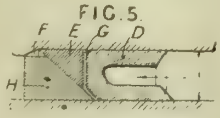
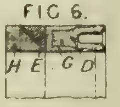


FIG 6.



leather or hard rubber, is further supported by a copper or brass etc. backing G. When the closed end of the ring D is rounded, the surface of the ring E conforms to it, or a hard-rubber etc. ring may be interposed between the ring D and the ring E. The flexibility of a rubber packing-ring may be increased by a groove in the surface in contact with the ring E. Fig. 6, shows a packing D with an extension and a copper sheathing extending along the lips. The packing is applicable either between a gun etc. and an internal mandrel, or between cover plates and the ends of the gun.

INTERNAL-COMBUSTION ENGINES.

126,663.—D. Napier and Son, A. J. Rowledge, and H. C. Tryon, 211, Acton Vale, London.—Jan. 31st, 1917.—A governor for internal-combustion engines, particularly those used on aircraft, comprises

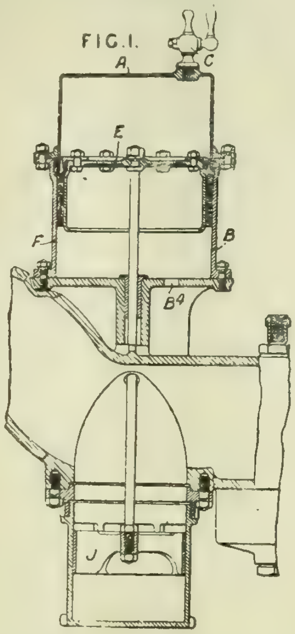


FIG. 1.

two chambers A, B connected together at their open ends, and gripping in an air-tight manner one end of an air-proof diaphragm F, of which the other end is similarly attached to a piston E. The chamber A has a cock C by which it may be connected to the atmosphere when the engine is at the ground level.

INTERNAL-COMBUSTION ENGINES.

126,771.—G. M. Blackstone, F. Carter, and E. Carter, Rutland Engineering Works, Stamford, Lincolnshire.— Dec. 5th, 1918.—Fuel is sprayed through a nozzle *h*1 in a fuel and air mixing block *h* and mixing port *j* such as is described in Specification 10165/14, and is ignited electrically, the resultant flame being directed to meet

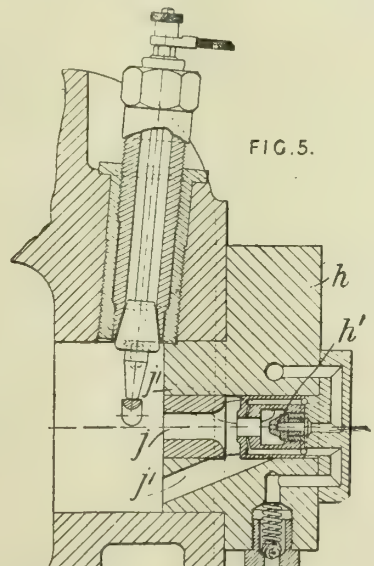


FIG. 5.

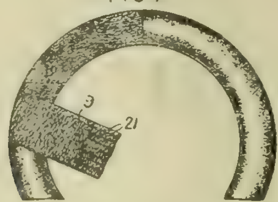
and fire the main fuel charge injected by a separate sprayer. Air circulating ports *j*1 may be provided around the main port *j*. The compressed air for the main fuel spray and the ignition fuel spray may pass through the same valve or through separate

valves, actuated in each case from an engine-driven cam shaft. When the valve only is used, a spring is arranged to make the main fuel injection later than that for ignition purposes. Specification 18187/08 also is referred to.

PACKING.

126,953.—E. H. ANGIER, Framingham, Massachusetts, U.S.A.—April 30th, 1919.—Strip material 9 for wrapping in helical turns on annular articles such as wheel tyres, coils of wire, etc., is provided with transverse gatherings or crappings in order that the strip may conform closely to the shape of the article and

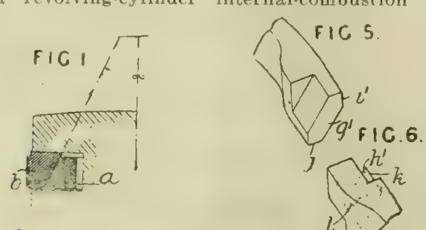
FIG I



to diminish danger of breakage. The strip consists preferably of two thicknesses of craped paper connected by a layer of adhesive such as mineral pitch, in which are embedded reinforcing-strands 21. The various turns are preferably sealed together so that a waterproof package is provided.

PISTON PACKING.

126,976.—M. BILLON, La Grette-par-Besancon, Doubs, and F. DUFAY, 1, Place Budapesth, Paris, both in France.—May 17th, 1919.—In a revolving-cylinder internal-combustion engine, con-

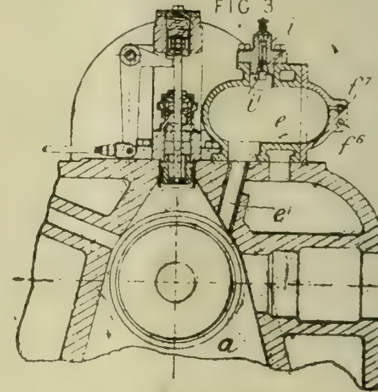


traction of the packing-ring b, Fig. 1, when the side thrust of the piston is varied or reversed, is prevented by the action of the centrifugal force on an inner bevelled ring a which bears on the bevelled inner periphery of the ring b. The ring may be of cast-iron and the ring a of steel. The ends of a packing-ring are formed with conical engaging surfaces and both ends bear against the cylinder and against the side of the packing-ring groove against which the packing-ring is pressed normally. In the form shown in Fig. 5, one end of the ring is cut away to form an inclined tongue $g1$, and the other end has a corresponding inclined slot $h1$. The surfaces $i1$ and k of the two ends bear against the cylinder, and the surfaces j and l against the packing-ring groove. In a modification, one end of the ring has a triangular tongue, and the other end a triangular recess.

INTERNAL-COMBUSTION ENGINES.

127,698.—G. M. BLACKSTONE, F. CARTER, and E. CARTER, Rutland Engineering Works, Stamford, Lincoln.—Nov. 8th, 1918.—In engines in which heavy fuel is injected as described in Specification 18.187/08, light fuel, with a small proportion of air, is drawn on the suction stroke from a receptacle $f6$ past a valve $f7$ into an auxiliary chamber e connected with the main combustion chamber a. It is delivered to the receptacle $f6$ in

FIG 3



measured quantities by means of a pump or drip valve. The auxiliary chamber is provided with an electric firing-device i, $i1$. The quantity of air drawn into the auxiliary chamber is only sufficient to allow the fuel to be sucked in, the remaining air necessary for combustion being compressed into the auxiliary chamber from the main combustion chamber. The auxiliary chamber may be connected with the main combustion chamber by a passage $e1$, or may be merely a recess in the main chamber.

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CONTENTS.

EDITORIAL.

HANDICAPPING INDUSTRY.

Is it very remarkable that the best financial men have become pessimistic during the past few months, and that many of them have not failed to express their very serious concern in regard to the future of industry generally, and the present rapid increases particularly. On all sides one is faced by economic and financial problems of an extremely serious character, the gravest being those in relation to raw materials, their price and supply, and the vicious spiral of ascending wages. The latter are due, it is asserted, to the materially increased cost of living—something like 130 per cent on pre-war prices. But these increased costs are being maintained by the reduction in our production and consequent exportation, influenced largely by the "ca' canny" policy adopted in almost every branch of trade.

This is not a fanciful or unsupported statement. The reduction in hours has not enabled the operatives to produce more per hour in consequence of the lessened fatigue, but has resulted in a smaller return per hour than hitherto. This is naturally handicapping industry, but it was not entirely in our mind when we set out to write this article.

The Budget is bullish. That is the general verdict, and it has been quickly analysed and sifted by the manufacturers, who have not been slow in voicing their protests. There must be in all our minds a desire to cut our losses and forget them, or in other words pay for the war as speedily as possible. But it is generally felt that we are going a bit too fast, or rather that there is a desire to make us travel quickly against our will and to our industrial detriment.

The greatest drawback attributable to the E.P.D. is the restriction of expansion. No firm is going to commence business with money as it is and a possible return of 9 per cent only, and consequently that expansion which is so good to the country generally will be nil, or practically so, while the duty remains. Already the writer knows of abstention from ordering new machines to augment a successful plant in the north. This is surely bad, and not what we require. At the moment the slogan is "produce more and yet more," but such a Budget as we have now before us will not help, but militate against this.

The men who are evidently going to pay for the war are largely those who fought it. They are now coming along into business, many of them anxious to branch out and establish their own works, but cannot face doing so in view of the onerous taxation with which they are faced. In industry, generally, every penny is urgently needed to meet the increased cost of raw materials, higher wages, and to aid in securing again that meed of foreign trade which was so reduced during the war. The alternative to the Budget is apparently a levy on capital. This would only handicap industry more. Although one appreciates the difficulties and the necessities, it would certainly appear as if the wish to settle matters early might have been modified, and the imposition spread over more years, and so more thinly.

HIGH-CAPACITY SWITCH GEAR.

By E. Austin.

Larger Electric Generating Stations.

The proposal to build now very much larger electric generating stations than those commonly constructed hitherto, has led engineers to devote a considerable amount of attention to the question of dealing with the very heavy currents which are liable to arise when large turbo generators are short circuited. Switchgear installed in these large stations must not only be capable of enduring high voltages, but also the very arduous conditions imposed when it is necessary to disconnect machines from the bus-bars at times of very heavy overloads. Modern electric generators coupled to steam turbines may develop instantaneously, when short circuited, currents eight or ten times greater than their normal working currents, dropping in about one second to the sustained value of about twice the normal current. Relays and tripping devices may take about ·2 second to operate when the initial rush of current may have dropped about 40 per cent, but it is obvious that in the case of very large generators rated at, say, 25,000 or 50,000 K.V.A., the amount of power to be dealt with by the switch is considerable.

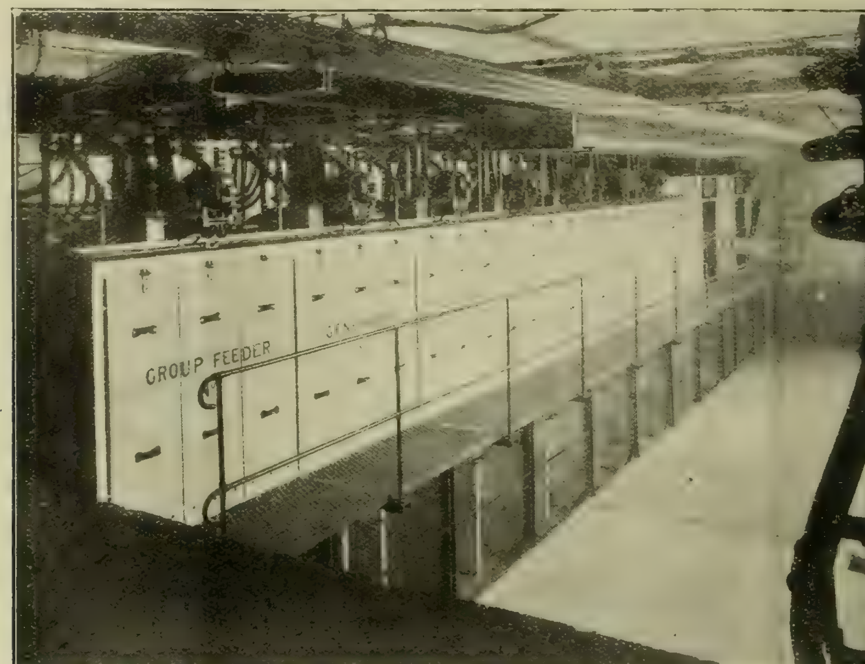


Fig. 1.—B T H. High-capacity Motor-operated Switch Gear installed in the Birmingham Electricity Works.

Fig. 2.—Section of Oil Vessel.

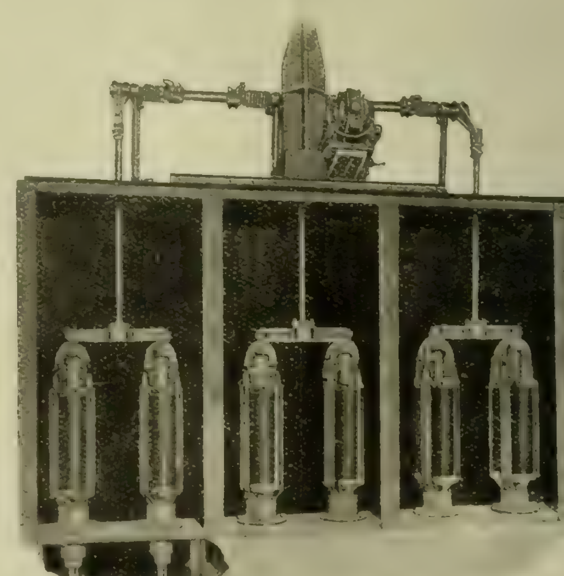


Fig. 3.—A 2,000 ampere 15,000 volt 3-phase B.T.H. Oil Switch with Oil Vessels Mounted in Tandem.

Reactance.

Short circuit currents on large power installations can be and frequently are limited by means of reac-

tance incorporated in the machines themselves, in transformers between sections of bus-bars or in series with feeders. Wherever employed, reactance limits disturbances in all parts of the system beyond it, and tends to isolate disturbance from all parts nearer to the source of supply, but inherent reactance in generators and transformers should, as far as possible, be relied upon, additional artificial reactance being employed only to ensure that disturbances are sufficiently localised, and the plant adequately protected against excessive stresses. Obviously, if reac-

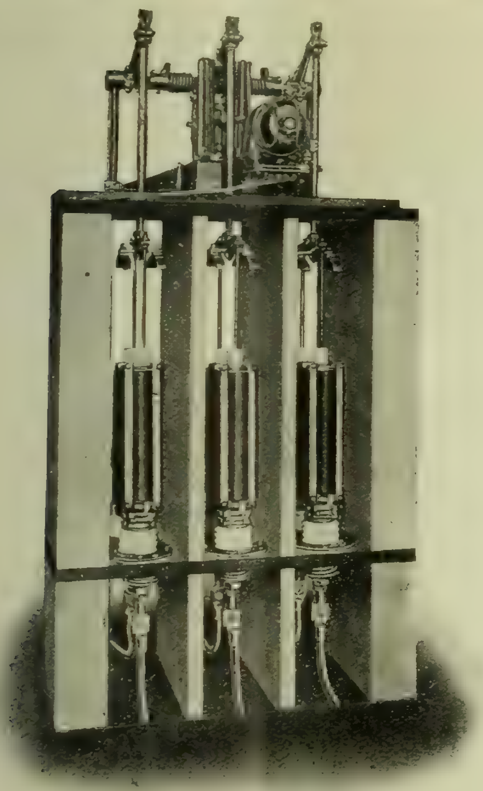


FIG. 4.—A 1,200 ampere 15,000 volt 3-phase T.B.H. Oil Switch in Stone Cells.

tances are connected between sections of the bus-bars, the distribution system must also be cut up into sections, otherwise the reactances will be of little if any value. But by sectionalising the bus-bars and distribution system the maximum possible short-circuit current can be greatly minimised. For example, with the bus-bars divided into five sections, and with a generator reactance of 17 per cent and a bus-bar reactance of 6 per cent, it is possible to keep the maximum short-circuit current down to three times the plant capacity instead of ten times the plant capacity, which is the average short circuit load at the present time. In other words, it is possible, with the aid of suitably arranged reactances, to build a 100,000 K.V.A. plant which will not produce heavier short-circuit currents than a 33,000 K.V.A. plant operated in the ordinary way.

Switches.

Switches suitable for the contemplated super-power stations must be capable of breaking with certainty the maximum possible short-circuit current to which they are likely to be subjected, and without sustaining damage which is likely to interfere with the operation of the plant. For many years past, British manufacturers have made switches of great mechanical strength, capable of resisting high explosive force, and it does not appear that it will be necessary to depart very widely from some of the existing designs when it comes to manufacturing machine switches for use in the new super-power stations. Investigation shows that the rupturing capacity of an oil switch depends mainly upon the speed at which the contacts part, the size and shape of the contacts, the quantity and depth of the oil, the length and number of breaks, the strength of the oil tank, the means of smothering the arc and of preventing the oil splashing, the method of mounting and enclosing the switch and, lastly, the means employed for limiting the pressures which arise owing to the accumulation and ignition of explosive gas above the oil surfaces.

Examples of Switches.

Some modern high tension and high capacity B.T.H. switches, which have proved very satisfactory in practice are shown in Fig. 1., and a brief description of the construction may prove of interest. The minimum length of the gap where the current is broken on each phase is 16 inches, or 32 inches for the two conductors, or 64 inches or the entire three-phase circuit. Each break is made in a separate oil vessel made of seamless drawn steel lined with insulating material fitted with caps and insulating bushes, and capable of withstanding enormous pressures. The contacts open and close at a speed of about five feet per second and the circuit is not ruptured until this speed has been attained. By means of baffle plates (see Fig. 2) in each of the oil chambers the arc is smothered, the tendency for the oil to leave the vessel is reduced, and the arrangement

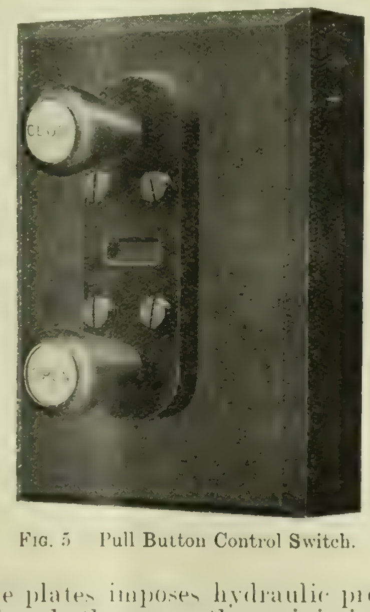


FIG. 5 Pull Button Control Switch.

of the baffle plates imposes hydraulic pressure upon the arc and cools the gases, thus minimising the risk of explosion above the oil surface.

When the current the switch has to deal with exceeds 300 amperes, the main contacts are situated outside the oil tanks where they may easily be inspected, and of course these contacts open first and transfer the current to the arc breaking contacts under the oil. The contacts are opened by means of

a small electric motor, which is claimed to take much less current to work it than a solenoid used for the same purpose. Each phase of these switches is enclosed in a separate brick or concrete compartment, and there is no metal work in the vicinity of the "live" parts. Two long arms connected by a cross bridge at the upper extremities, and dipping into separate oil vessels and entering expanding sockets at the bottoms of the vessels, constitute the moving contact elements of each phase of a switch. The vessels are mounted on porcelain insulators, and the porcelain bushes at the top insulate the plunger rods from the vessels and guide them through the full length of their stroke, the main contacts in the case of switches for over 300 amperes being made on the caps of the oil vessels by bushes carried on the cross-head which joins the two vertical rods. The cross-heads are clamped at their centres to long wooden rods which pass through the tops of the concrete or brick switch cells, and are attached at their upper ends to arms forming part of the operating mechanism. This mechanism, as can be seen from Fig. 1, is mounted on top of the switch cells and away from all live parts, and is easily inspected. The oil vessels may be mounted in the cells side by side in a line parallel to the front of the switch, as shown in Fig. 3. or in a line at right angles to the front as in Fig. 4., the oil vessels being inspected by opening the doors at the back and front of the switch cells. Of course, when the oil vessels are arranged in a line parallel with the front of the switch, the overall of the switch is considerably increased, but the arrangement is very satisfactory in the cases of heavy current or extra high tension switches, as it gives better access to the oil vessels and heavy switch connections. Switches built in accordance with this plan can, of course, have solid backs and be placed directly against walls, access to the oil vessels and switch connections being obtained by opening the doors at the front of the switch cells.

The movement imparted to the oil by the expansion of the gases formed by the arc when the circuit is opened under load is checked and diverted by the baffles (Fig. 2) allowing the gases to separate from the oil through the vent-hole in the cover of the vessel. The oil itself is forced back under pressure into the region of the breaking arc, thus shortening the time of breaking the arc confining the disturbance or explosive effort, eliminating flashes due to hot gases and minimising the ejection of oil from the vessel and before the oil reaches the cover of the vessels it loses its velocity. A small twin switch of the pull-button type (see Fig. 5) serves for the entire control of these high capacity oil switches. One of the knobs of the control switch serves for opening the main switch and the other knob for closing it, and the red and green lamps show at a glance whether a machine is connected to bus-bars. In the event of the lamps failing, the position of the main switch contacts can be ascertained by inspecting a small vane with a red and green segment and fixed between the knobs shown in the figure. The small motors which operate these heavy duty oil switches are usually high speed series wound machines, and they operate mechanism which stores up energy in compression springs, and as the opening and closing of the main contacts are brought about by these springs, the operation of the switches is in no way dependent upon the speed and power of the motors.

DESIGN AND APPLICATIONS OF "HIGH-SPEED GEARING."

By M. CORONEL.

THE advent of high-speed gearing is due to a true conception of what accurate machine-cut and generated gearing should be, and its use in places where the old-fashioned cast gearing was quite out of the question is a direct result of such consideration. By the improved methods of manufacture we have obtained accuracy and high efficiency, combined with a positive drive; the subsequent ease and absence of noise are further advantages.

As indicated above, the method of manufacture has had a great deal to do with this; but other considerations, such as electric driving by high-speed motors, and the advent of the steam turbine for driving all kinds of machinery at speeds much lower than the extremely high speed of the motor or turbine, have been further determining factors.

Following on these remarks, it is as well to survey briefly the various methods now in use for producing the results in gearing, later to be described, although it is not proposed to go fully into the manufacture of such gears. For a description of gear-cutting machines see Mr. Charles Johnson's paper on gearing, read in Newcastle.

Thus, briefly stated, modern gearing (not worm gearing) is manufactured in three different ways :—

1. By the end mill process, a not very accurate method.
2. By the hobbing process.
3. By the shaping process, which latter under certain conditions is the most accurate.

To obtain an accurate and noiseless working gear of any kind, be it worm, spur, or bevel gearing (under spur gearing is here included helical, spiral, double helical, etc.), the gears should be generated. Generating is the name given to a process which cuts the gear with a cutter, or rack, having the shape of tooth of the wheel which is to work in the gear, having at the same time movements, gear and cutter, similar to those of wheel and pinion when at actual work. Now, only the third method, and to some extent the second method, lend themselves to such a process; and that is one of the reasons why the first method is not very accurate. Amongst the applications of the third method, the "Sunderland" gear shaper method of production is undoubtedly the best and soundest, as it gives very accurate gears, bearing along the full length of teeth whether straight, helical, or double helical teeth have been cut. The first method is used, or should be used, only for small orders for which it does not pay to make special hobs or shaping cutters. Certain helical gears (such as triple or quadruple gears, Citroen gears, etc.) can, however, be made continuous only by this process. The second method has in certain cases proved the most efficient method as far as very wide turbine reducing gears are concerned. The cost of the hob is, however, an item of expense to be considered. For cases where the expense of making a hob is not warranted, what is called a fly cutter is often used. The fly cutter is really a very small portion of a hob having the thickness of a shaping tool.

The third method is undoubtedly the most accurate, being true to the theoretically correct process of manufacture and giving a generated tooth form. Gears cut with this method work with the least noise, and given proper design, material, and lubrication, can be run noiseless at 10,000 revolutions per minute.

After these preliminary remarks, we will now proceed to describe the design, the material, and the characteristics of the various gears used for high-speed transmission at the present day.

These can be classified according to their shape and according to the use to which they are put. We propose to examine separately each of the following :—

A. Worm gearing.
B. Bevel gearing.
C. Spur gearing,

and in the case of spur gearing its classification according to use, as follows :

GENERAL WORK.

1. Light type for electrical drives, shop drives, and other light work.
2. Heavy type for collieries, direct-driven rolling mills, haulage work, etc.
3. Vertical double reducing gears.

TURBINE GEARING.

1. Land turbine reducing gears.
2. Marine turbine reducing gears.

WORM REDUCING GEARS

The worm and worm wheel was the earliest kind of gearing to be adapted to high speeds. In small units, and for low speeds,

the worms are made of mild steel, the worm and its shaft being made of one piece. The wheel is of cast iron throughout, and is keyed on its shaft. The bearings for the worm are ball journal bearings with one ball-thrust bearing to carry the axial thrust. The bearings of the wheel are usually brass bushes. The whole is enclosed in a cast-iron casing; the wheel bearings are lubricated by oil cups, and the ball bearings run in suitable grease. The casing is split in the axis of the wheel shaft in a plane perpendicular to the side of the wheel. The ball bearings may be taken out separately, and these, together with the worm, withdrawn through one hole.

For larger units the wheel is usually made of cast iron or steel centre, with a phosphor bronze rim shrunk on. The worm is made from a hardened special high-tensile steel forging of fairly high-carbon content. Both worm and wheel are ground, the former, of course, after being hardened.

For medium and light duties the worm shaft runs in a system of ball bearings with ball-thrust bearing. For the heavier duties, however, the worm shaft runs in bronze bearings fed by ring oiling, and has an additional thrust bearing collar block. The wheel is of cast iron or steel, with a phosphor bronze ring shrunk and pegged on, and its shaft runs in self-oiling ring bearings. The ring, when thus shrunk on, should be of ample section, as the tendency exists to twist the rim from its centre.

The great disadvantage with worm gearing is that the action is not rolling, but sliding, as in the case of screwing a nut on a bolt. An attempt has been made to avoid this disadvantage in the "F.B." worm gearing designed and manufactured by Messrs. David Brown and Sons Ltd., Huddersfield; the flanks of the worm thread are not straight, but of a cycloidal shape, and its worm wheel is generated from this form of thread. It is claimed for these gears that they have a larger contact surface and a rolling action, and that the loss through friction is considerably reduced. Hobbed worm gearing is the most accurate, but it is costly to produce.

Heavy worm gearing should have self-oiling bearings throughout, and a separate thrust block for the worm shaft. A gland with packing is often provided on that end of worm-wheel shaft which protrudes from the casing, the other end being closed.

It is desirable that no worm wheel be made with less than 30 teeth. Gears are made with the worm wheel on top of the worm, or *vice versa*, as circumstances may require, also with worm and wheel arranged horizontally.

One great advantage of worm gearing is that it may be made self-locking so that it does not run back when a shaft, or the source of driving, fails; this is of great advantage for such work as lifts, haulage gears, etc.

To overcome the disadvantage of the one-sided thrust on worm wheel for heavy duties, etc., the above-named firm have invented and patented a double-reduction gear, consisting of two worm wheels side by side, driven by worms of opposite hand, each of the latter connected to a pair of spur gears, thus enabling the whole to be balanced within itself.

BEVEL GEARING.

This kind of gearing is least used for high-speed purposes, being expensive to manufacture accurately. The gears themselves can be produced by the end mill, or better still by the "Sunderland" shaping and generating method. But, even when the gear is accurately cut, the design of casings, bearings, lubrication, and also the end thrust occasioned by this class of gear, make it difficult to meet the requirements for high-speed continuous and noiseless running.

We therefore pass on to spur gearing, which is the most important class, and the most commonly used.

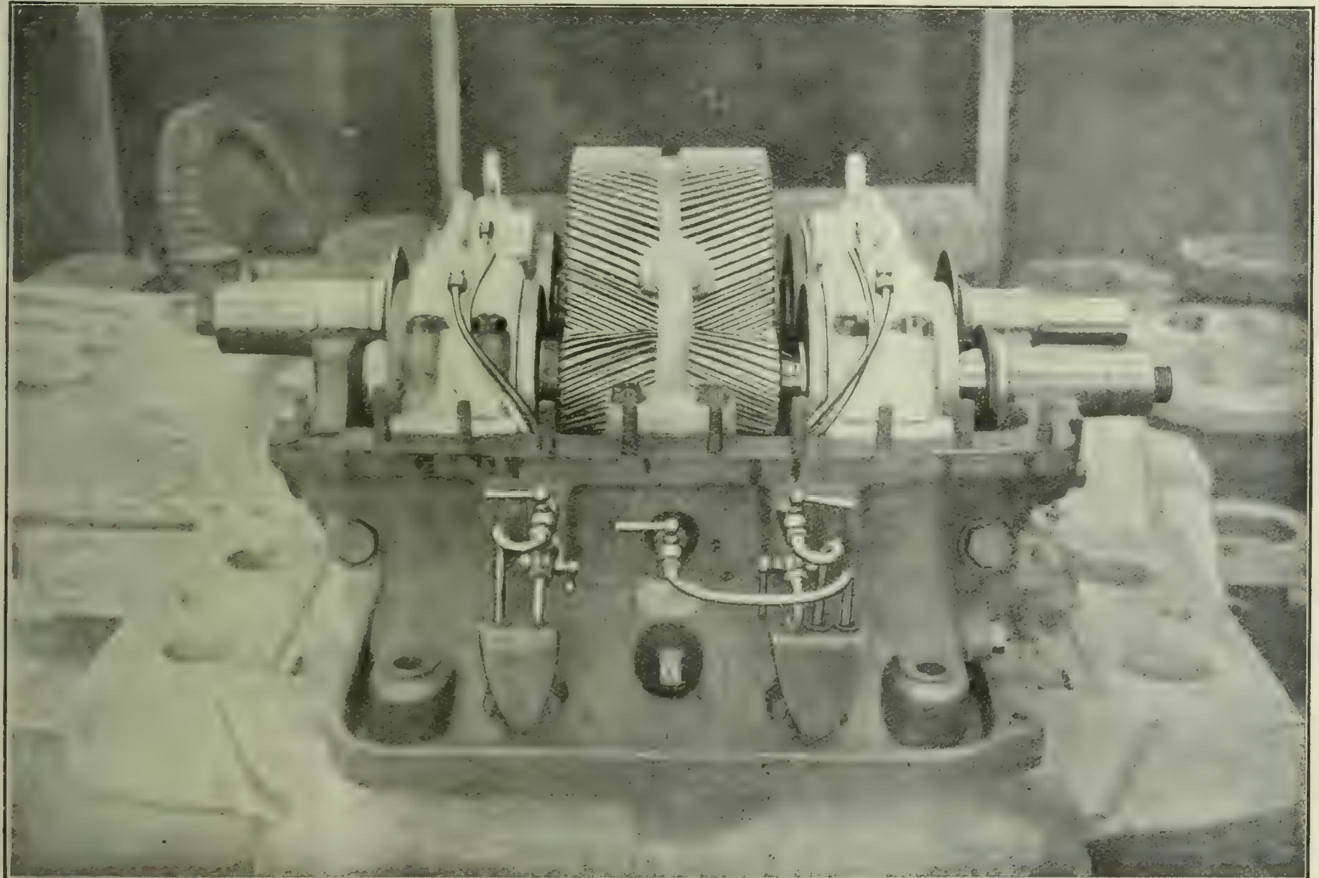


PLATE I.—SINGLE TURBINE REDUCING GEAR.

SPUR GEARING.

The satisfactory working of this kind of modern high-speed gearing depends on accuracy of tooth form and on a proper selection of material. The form commonly used in this class is the involute, and the gear is generally arranged as double helical. The shafts are carried in efficient bearings, the whole being enclosed in cast or wrought-iron casings. The lubrication is continuous and either automatic or forced. As a matter of fact, gear design has required scientific work of the first order, and of late years has been on the same level as high-class steam and other engine design.

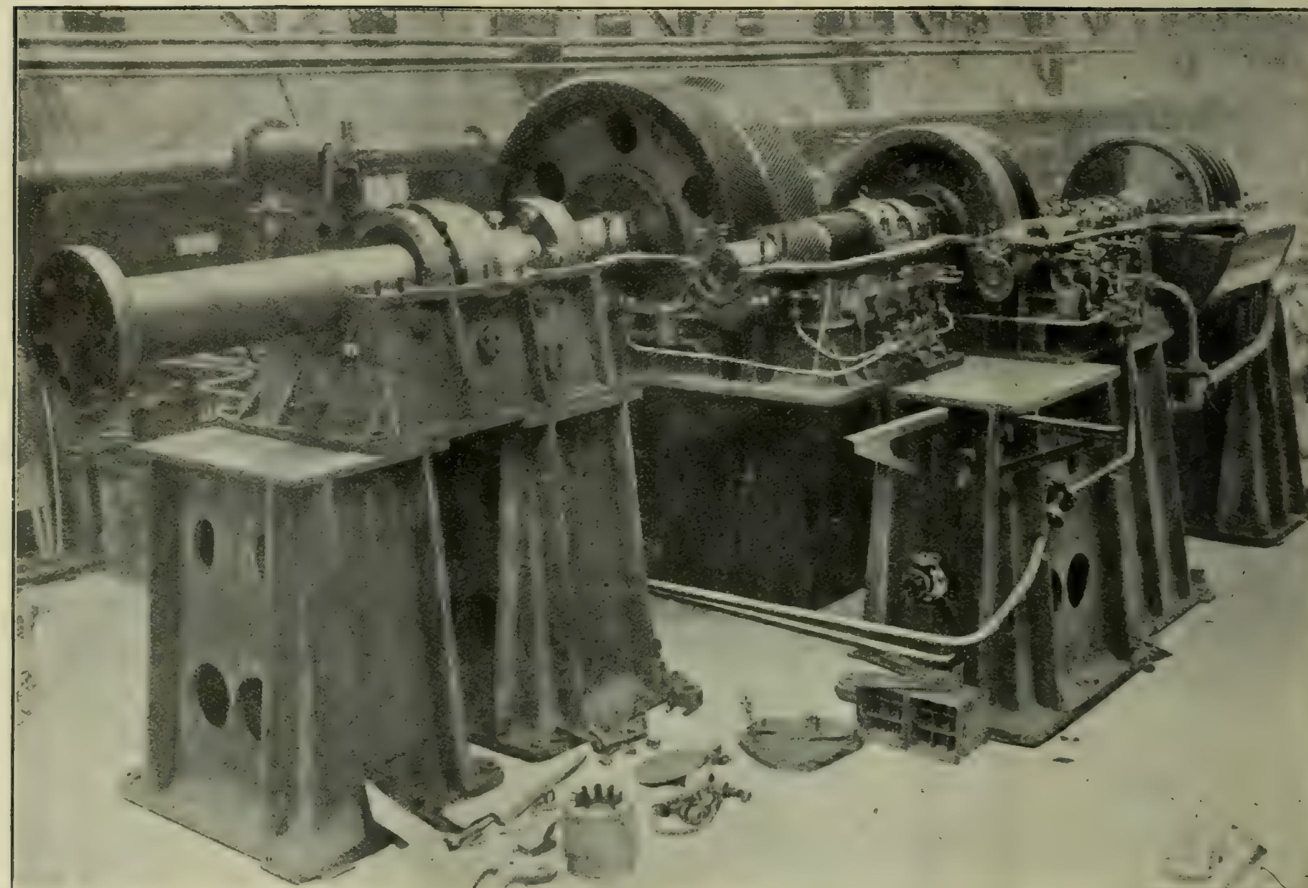


Plate 2.—Double Marine Reduction Gear.

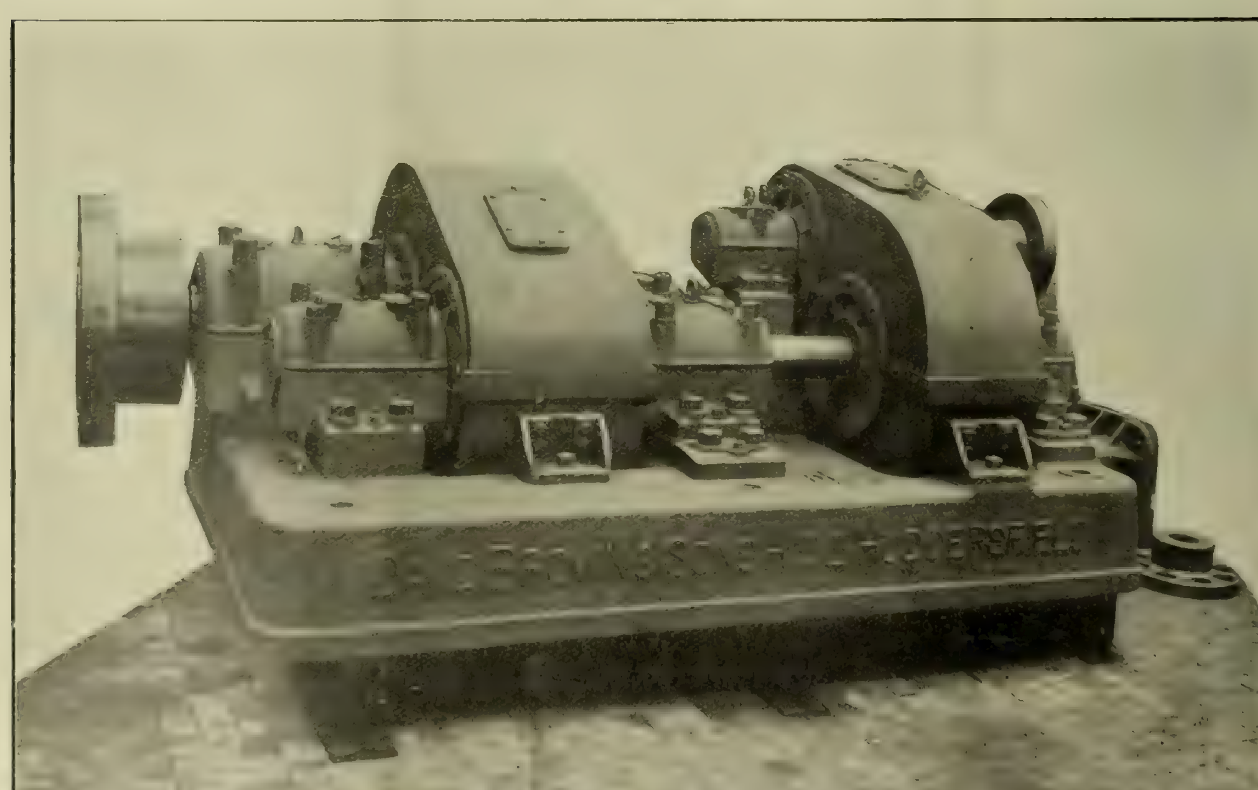


Plate III. Double Reducing Gear.

We will now examine the various classes of spur gearing more minutely.

Light single reducing gears, as used for direct driving shop line shafting, electric driving of machine tools, and other light machinery.

These reducing gears consist of a pinion often made of 3 per cent nickel steel, either keyed on pinion shaft, or, if very small in proportion to shaft, made out of one piece with same. This pinion runs together with a double-helical cast-iron wheel keyed to a mild-steel shaft, both pinion and wheel shafts being carried in bearings. These bearings form part of a cast-iron casing enclosing the whole, which is split horizontally in the plane of the shafts.

In the smaller units the bearing caps are part of the top casing, but in the larger sizes the bearing caps can be removed without disturbing the casing. The bearings are usually ring oiling, and the gears run in an oil bath which is formed in the base of the bottom half of the casing. For small units, and small circumferential speed of wheels, such oil-bath lubrication of the gear wheels is quite sufficient; but when the circumferential speed exceeds 1,000 ft. per minute, cavitation sets in, and other means

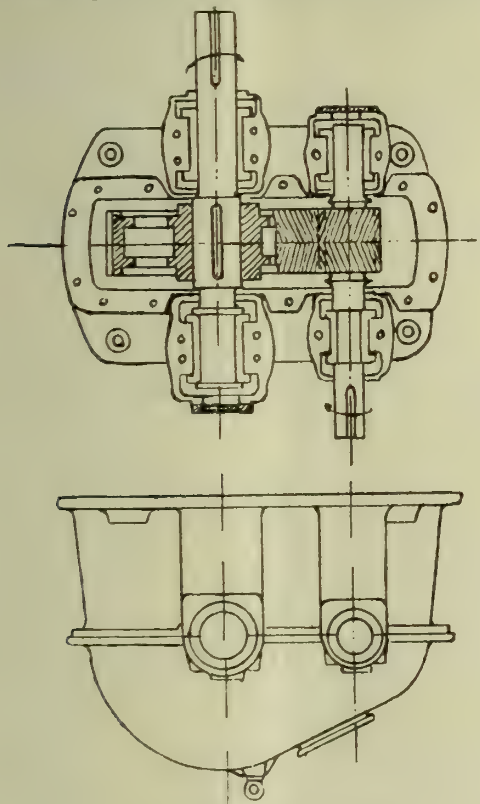


FIG. 1.—LIGHT SINGLE REDUCING GEAR.

of lubrication must be resorted to. The usual alternative is to have oil supplied by gravitation through sprayer nozzles, which will be described later. There are oil-level gauges to each bearing, and one to the casing, to show the oil level in each. Inspection doors and oil-hole covers are provided; as well as means for draining off the waste oil. (See Fig. 1.) In this kind of gear the centres are not adjustable. The construction can be seen from Fig. 1. The shafts are enlarged on each side of one hand of bearings, so that when expansion occurs both shafts move in the same direction, the other hand bearings having no shoulders on the shafts. The bearings are of phosphor bronze, and in halves. The stress through the smallest diameter of shaft, usually at the bearing, is about 4,500 lbs. per square inch. The bearing surface pressure is about 200 to 500 lbs. per square inch. The shafts are enlarged where pinions and wheels are keyed on, also where the couplings are fixed.*

(To be continued.)

*In giving these and other values in the text, the Author wishes it to be understood that they are extremes, and not common practice.

THE AIR COOLING OF PETROL ENGINES.

By A. H. GIBSON, D.Sc.,
University College, Dundee.

(*Continued from page 233.*)

TESTS of water cooled engine may be carried out either with or without an air blast. In the case of a large multi-cylinder engine an air blast is usual in

TABLE II.

Test Series No.	Engine.	Compression Ratio.	Revs. per minute.	B.H.P.	Petrol, lb. per B.H.P. per hour.	Heat from working fluid expressed as H.P. (A).	Heat from cooling surfaces in 60 mile wind (H.P.).	A / B.H.P.
1	R.A.F. 3A 12-Cyl. Vee. Cyls. 4½ in. by 5½ in.	4·7	1100 1400 1700	155·7 190·4 214·0	0·520 0·535 0·548	144·0 175·0 204·3	67·0 67·5 68·0	0·925 0·915 0·950
2	*Hispano Suisa.* 8 Cyl. Vee. Cyls. 4·72 in. by 5·11 in (120 mm. by 130 mm.).	4·8	1000 1200 1400 1600	107 130 150 168	0·595 0·587 0·584 0·580	100 115 132 143	62 62 62 62	0·93 0·89 0·88 0·85
3	*Fiat.* 6-Cyl. straight line. Cyls. 6·3 in. by 7·08 in. (160 mm. by 180 mm.).	5·3	1000 1250	195·5 244·0	0·589 0·579	163 195	51 51	0·83 08 0
4	*Renault.* 12-Cyl. Vee Cyls. 4·92 in. by 5·90 in. (125 mm. by 150 mm.).	4·8	1200	224·0	—	216·6	69	0·97
5	*Sunbeam.* 12-Cyl. Vee. Cyls. 3·74 in. by 5·32 in. (95 mm. by 135 mm.).	5·2	2100	223	0·520	199	65	0·89
6	*Mercedes* Single-Cylinder. Cyl. 6·3 in. by 7·08 in. (160 mm. by 180 mm.).	4·5 5·0 5·5 6·0	1400 ,, ,, ,,	26·9 27·4 28·2 28·0	0·551 0·563 0·565 0·586	23·2 22·2 22·0 20·7	No wind do. do. do.	0·86 0·81 0·78 0·74
6	Do.	4·5 5·0 5·5 6·0	1600 ,, ,, ,,	30·3 30·9 31·6 31·4	0·593 0·585 0·593 0·585	25·2 24·1 23·1 21·7	No wind do. do. do.	0·83 0·78 0·73 0·68
7	*Ricardo Tank Engine* 6-Cyl. straight line. Valves in side pockets with inlet over exhaust. Cross-head piston. Cyls. 5·625 in. by 7·5 in. (143 mm. by 190 mm.).	4·3	1200	162·9	0·554	164·2	No wind	1·10
8	*Adler "L" head motor car engine.* 4-Cyls. Cyls. 3·38 in. by 5·31 in. (86 mm. by 135 mm.).	4·2	1200 1400 1600 1800 2000 2200		0·620 0·590 0·571 0·570 0·580 0·605		No wind do. do. do. do. do.	1·58 1·51 1·46 1·43 1·45 1·51
		Air	*Cooled*	*Cylin*	*ders.*			
9	*Air cooled single aluminium cylinder with overhead valves.* Cyl. 3·94 in. by 5·51 in. (100 mm. by 140 mm.).	4·6	1600 1800 1800 2000 2000	14·6 16·2 15·1 16·1 15·3	0·513 0·543 0·516 0·534 0·522	15·6 18·8 16·4 17·7 16·2	8·1 8·8 8·1 8·4 8·0 In wind 64 m.p.h.	1·07 1·16 1·09 1·10 1·06
10	*Air cooled single aluminium cylinder with overhead valves.* Cyl. 4·5 in. by 5½ in. (114 mm. by 139·5 mm.).	4·6	1100 1200 1300 1400	13·2 14·5 15·5 16·6	0·560 0·560 0·552 0·543	14·5 15·2 17·4 18·3	8·3 8·9 9·1 9·6 In wind 65 m.p.h.	1·10 1·05 1·12 1·10

order to keep the valve springs and exhaust pipe moderately cool and to remove the exhaust gases. In this case, a very appreciable amount of heat is dissipated from the surfaces of the water jackets and crank case, and the heat actually passing into

the jacket water from the working fluid is greater by this amount than that computed from a measurement of the weight and inlet and outlet temperatures of the jacket water. By carrying out duplicate tests with the same wind speed but with different jacket water temperatures, it is, however, possible to determine the heat actually passing through the walls in such a case, and this may be checked by the results of tests with no cooling wind. In the latter case a small experimental correction for radiation from the surface is necessary.

Figures are available from a number of tests on engines of various types, from which these values have been obtained, and the essential data of these tests are given in Table II. For convenience, the heat passing into the walls and piston has been expressed as a fraction of the brake horse power, 42·42 B.Th.Us. per minute being taken as the equivalent of 1 H.P. The heat passing through the walls is denoted by the symbol A.

With the exception of series 7 and 8, all these tests were carried out under the supervision of the author. The figures of series 7 are given by the courtesy of Mr. H. Ricardo from tests made by him. Those of series 8 are from tests published by Prof. Riedler.*

Series 1 to 5 were carried out on standard aero engines, and the measurements were made in the coarse of full-throttle bench tests, with the petrol adjusted to give the weakest maximum load mixture for the particular engine.

The values of the heat-loss from the cooling surfaces, given in the penultimate line of Table II., have been computed in every case for a mean jacket water temperature 65 deg. Cen. above that of the air.

Series 6 was carried out on a single-cylinder Mercedes engine in the course of tests to determine the effect of varying the compression ratio.

The tank engine of Series 7 is fitted with pistons of the cross-head type, and the air passing to the carburettors is circulated around the crosshead guides and under the pistons. During its passage the temperature of the air is raised about 60 deg. Fah. This degree of air cooling reduces the heat given to the walls. The value of A/B.H.P. deduced from the jacket water measurements alone is 1·01. The absence of this air cooling would bring this value up to 1·05, and an allowance of 5 per cent for radiation gives the value 1·10 given in Table II. It should be noted that with a crosshead piston the piston friction is reduced, and hence, to some extent, the heat given to the cylinder walls.

In the case of air-cooled cylinders of Series 9 and 10, a complete heat balance was obtained, the exhaust gases being passed through a calorimeter, and an analysis being made from which the heat-loss due to unburnt petrol could be obtained. The heat-loss denoted in the last column of the Table is obtained by differences from the balance sheet; this includes the heat passing through the walls and piston dissipated from the surface of the cylinder and crank case, and carried away by any oil vaporised in the crank case. The cylinder wall and fin temperatures were measured, and the same cylinders were afterwards erected as radiators in a wind tunnel with circulation of hot water through the barrel, and the actual heat dissipation from their surfaces at the same mean temperature and wind velocity as in the running tests was obtained. These values are given in the penulimate column of Table II. From these figures it appears that of the total heat dissipated from these cylinders, only 53 per cent in Series 9 and 60 per cent in Series 10 is actually removed from the cooling surfaces of the cylinder itself. The reminder, ranging from 49 per cent to 40 per cent of the heat equivalent to the brake horse-power, is dissipated from the surfaces of the crank case, and by oil vaporised from the lower surface of the piston and walls. These cylinders are lubricated by splash lubrication.

The author would draw special attention to these figures. The amount of heat dissipated from the internal surfaces of a petrol engine depends very greatly on the amount of oil reaching these surfaces. Where the oil supply is only sufficient to give adequate lubrication, this component of the heat dissipation is reduced; more heat must be removed from the outer cooling surfaces, and the cylinder temperature is increased. Variations in the degree of cylinder lubrication readily explain many of the inconsistencies which have been observed in temperature measurements on cylinders otherwise apparently similar.

General Results of Tests.

The results show that the heat transmitted from the working fluid to the cylinder walls and piston may range from 70 per cent to 150 per cent of the heat equivalent of the brake horse-power, depending on the design and conditions of operation of the engine.

An examination of Series 1, 2, 3, 6, 8, 9 and 10 shows that under normal conditions of operation, and for speeds below that giving maximum power, the speed of the engine has not a large effect on the transmitted per brake horse-power. Usually, as in Series 2, 3, 6 and 8, this diminishes with an increase of speed. In Series 1, 9 and 10 the effect of speed is negligible. In general, the diminution in this ratio with increasing speed is more marked in an engine with comparatively low compression ratio.

Table III. shows the temperature attained at a point on the side of the combustion space of an aluminium cylinder $4\frac{1}{2}$ in. bore by $5\frac{1}{2}$ in. stroke, with a compression ratio of 4·7, in a cooling wind of 53·5 miles per hour.

TABLE III.

Revs. per minute	B.H.P.	Temp. deg. C.
800	10·2	100
1000	12·8	103
1200	15·4	124
1400	18·0	123
1600	19·7	136
1800	20·6	138

The temperature of the cooling wind was 22 deg. Cen. The tests were carried out at full throttle, with petrol and spark adjusted to give maximum load conditions at all speeds. The normal speed of the engine is 1,400 revolutions per minute, and the result shows that from 1,200 to 1,800 revolutions per minute the effect of speed on the cylinder tem-

*"The Scientific Determination of the Merits of Automobiles." A. Riedler, The General Oil Publishing Co. Ltd., London.

perature is very small. If the temperature-difference between the air and the cylinder at the given point be taken as a measure of the heat dissipated from the cooling surfaces, it appears that the heat dissipated per brake horse-power is 13 per cent less at 1,200 than at 800 revolutions per minute, and 15 per cent less at 1,800 than 1,200 revolutions per minute.

From Series 6, it appears that the heat transmitted per brake horse-power diminishes appreciably with an increase in the compression ratio. Since, within limits, the brake horse-power increases with the compression ratio, the total heat to the walls does not diminish so rapidly as the ratio of A/B.H.P., and may, indeed, increase with an increase in the compression ratio. Tests on any given engine usually show that there is some fairly definite compression ratio giving a minimum wall temperature, and show that for moderate variations of compression ratio on either side of this value, the variation of temperature is small.

This point is brought out by the test figures from an aluminium air cooled cylinder of 100 mm. bore by 140 mm. stroke, under maximum load conditions in a 64 miles per hour wind, given in Table IV. Attention is drawn to the figures for petrol consumption and brake mean effective pressure in these tests, as indicating the possibilities of such a cylinder.

TABLE IV.

Compression ratio.	Brake mean effective pressure.	Petrol. lb. per b.h.p. per hour.	Mean temperature of barrel deg. C.		Remarks.
			Top.	Bottom.	
4·6	116·2	0·530	180	105	
5·0	119·3	0·507	170	95	
5·4	122·0	0·490	157	89	
5·8	125·0	0·475	154	85	
6·2	129·0	0·480	183	110	Occasional pinking.
6·4	123·0	0·520	212	135	Heavy pinking.

(To be continued.)

THE AMOUNT OF STEAM USED BY STEAM JETS.

By T. ROLAND WOLLASTON.

THIS is the title of a brochure sent to us by Mr. David Brownlie, a reprint of one of his series of contribution to "*Engineering*," entitled "Exact Data on the Running of Steam Boiler Plants." Mr. Brownlie has conducted some hundreds of tests to ascertain the efficiency of existing boiler plants just as they are—that is to say, without any preliminary tuning up. His methods, commercial and technical, have not escaped criticism. After reading much that he has written, and hearing him speak in public discussion upon the subject, we would hesitate to accept as "exact" all the data he has published, nor should we agree that his methods are such as are, or should be, beyond the powers of any qualified works engineer. In spite of the protestations made by British manufacturers, and in the daily press during the last ten years, that we are running our factories on lines as scientific as our American and Continental competitors, Mr. Brownlie has shown in the clearest manner that, with modern developments and inventions available, a large proportion of our British plants are showing efficiencies (*sic*) which Jas. Watt, in his own day, would not have tolerated. While, as above stated, we would hesitate to accept all the statistics published by Mr. Brownlie as scientifically exact, we have no reason to doubt their relative accuracy, and, while we have little hope that they will be usefully assimilated by the manufacturer himself, we consider them invaluable to the earnest engineer.

In the series of articles, including the one now in question, Mr. Brownlie claims little more than the circulation of actual results obtained, but each article does include some comments thereon, and frequently, notably in his recent paper for the Institution of Mechanical Engineers, he suggests conclusions from his own statistics which, we submit, are not wholly justifiable. May we illustrate this submission by one or two examples from this brochure on steam jet consumption. Very many of the patent boiler furnaces, automatic and hand fired, in common use employ steam-jet induced draught. The analyses have been for the purpose of ascertaining what proportion of the steam generated is expended in producing the draught, and is consequently not available for power or process work. Let us take "Table 11, type A, Sprinkling Stoker," because it is the longest list (comprising no less than 25 installations). We do not know whose make of stoker type A represents, nor does it matter much, as our point applies to practically every one of the fourteen tables given.

In the heading to this table we find the average steam jet consumption for the type given as five per cent of the total evaporation, the lowest being No. 1 = ·5 per cent, and the highest, No. 25 = 15·1 per cent, but we also notice that in all the examples up to No. 21 = 5·3 per cent, the jet consumption is below 5 per cent. The average up to No. 21 is 3·07 per cent. That is to say that just because three or four out of 25 installations are badly managed the whole class is rated 40 per cent too high in jet consumption. And this particular table is full of anomalies. For example, No. 1 case gives 5,057 lbs. evaporation per boiler on ·5 per cent jet steam. No. 25 case gives 4,343 lbs. evaporation per boiler on 15·17 per cent jet steam, while No. 11 gives 11·146 lbs. evaporation per boiler on 3·25 per cent jet steam. Presumably these boilers are approximately equal in size.

The whole trend of this and of Mr. Brownlie's other papers proves not that British boiler plants and their associated gear are efficient or inefficient (as the case may be), but that a large percentage of their users are either crassly ignorant or wholly indifferent regarding fuel economy.

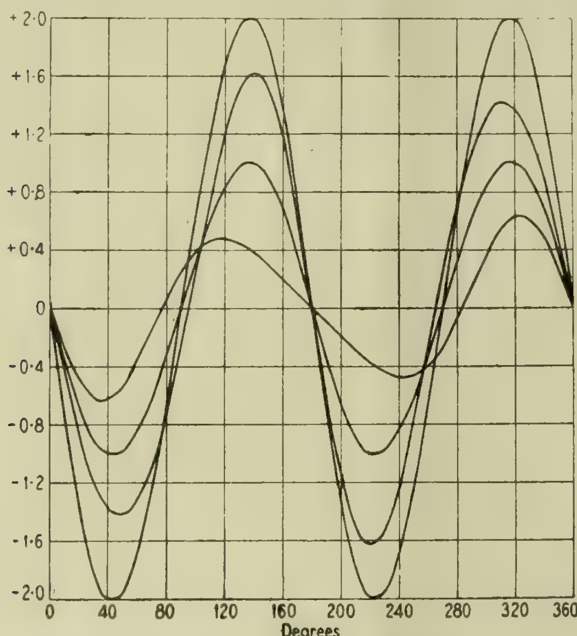
DRAUGHTSMEN'S AGREEMENT.—The Association of Engineering and Shipbuilding Draughtsmen has come to an greement with the more recently formed Architectural Draughtsmen's Association, under which the former Society agrees not to accept purely architectural draughtsmen, while the latter agrees to leave steel structural draughtsmen to the A.E.S.D. There is also a provision that doubtful cases shall be submitted by either Union to the other before a member is accepted. The new agreement which indicates the intention of the A.E.S.D. to undertake serious organising work among draughtsmen in steel works, is likely to be followed by a considerable expansion of membership, particularly in the South Wales area, where organisation is still weak.

LUNDBERG'S SWITCHING COMPETITIONS.—We understand that those well-known electric-light switching examinations which were conducted with such success by Messrs. Lundberg during the years previous to the war have again been resumed, and that the papers for the next examination will appear in the columns of our contemporary *Electricity*, commencing with the issue for 23rd April.

INERTIA TORQUE IN CRANKSHAFTS.*

In the present paper it is the author's intention to compare internal stresses in the crankshaft set up by inertia torque, and the consequent rotary reaction on the engine as a whole. This must not be confused in any way with the question of linear balance as ordinarily understood, though of course, the two subjects are very closely related, and the mathematical investigations are identical up to a certain point.

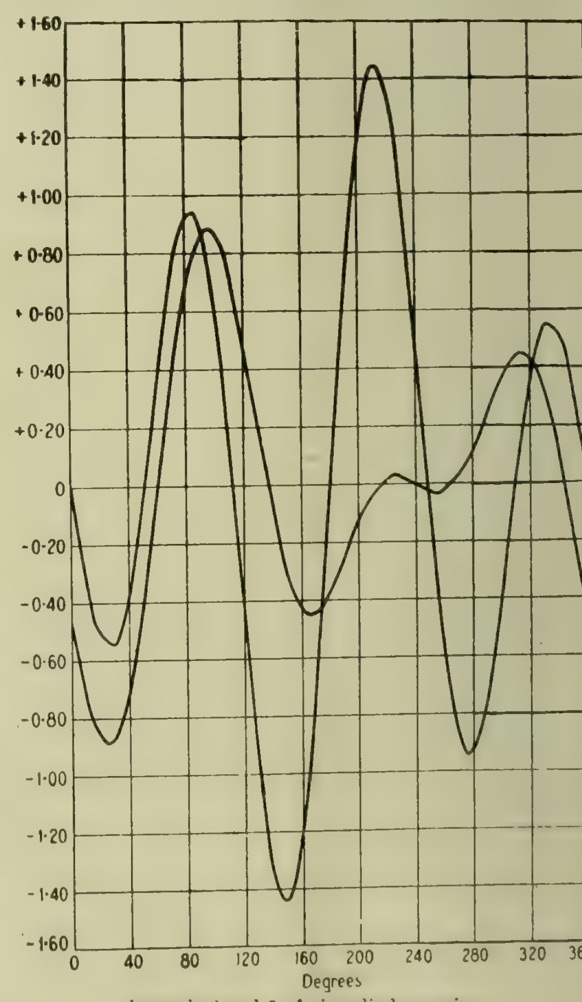
In considering the linear balance, we only concern ourselves with the net resultant horizontal and



Values of K for each journal of a four-cylinder engine.

vertical forces due to the inertia of the reciprocating parts so far as they affect the engine as a whole and are therefore felt. This question of balance has been exhaustively dealt with in many quarters, ranging from a paper read by Capt. Riall Sankey and Mr. Mark Robinson in April, 1895, before the Institution of Naval Architects (in which the practically perfect linear balance of the six-cylinder engine was proved), to that read by Mr. Lanchester before this Institution (*a*), and therefore, it is the author's desire to avoid treading on the same ground as far as he possibly can. In passing, however, he would point out that this is purely a species of homœopathic treatment, that is to say, it consists of neutralising the external effect of one set of inertia forces by creating another set, for instance, by multiplying the number of cylinders, by the use of balance-weights or the Lanchester Anti-Vibrator, but in spite of this treatment the forces are still there. Spasmodic attempts have also been made to deal with the rotary balance of the engine as a whole by the use of two crankshafts, as in the early Lanchester engines, or in the Lucas-Valveless, but here again the treatment is still only a species of camouflage.

This treatment, from the point of view of linear balance, is, of course, a very essential one—the most essential from every consideration—but taken by itself it is apt to lead to rather false conclusions. If this linear balance were to be the sole determining factor, the opposed-cylinder 180 degree crank type, and the six-throw crank with six or 12 cylinders would appear to be the only types worth a moment's consideration. In the former, the algebraic sum of the forces in any direction is zero, while the couple due to the cylinders not being in line may be reduced to negligible proportions by careful design, or it may even be totally eliminated. In the six-throw crank type, the algebraic sum of the forces at right angles to the cylinder centre line is zero, the couple is zero, and the algebraic sum of the forces in the plane of the cylinders is somewhere about one eight-thousandth part of the forces due to the complete line of reciprocating parts, assuming a



Journals 2 and 5 of six-cylinder engine.

normal connecting rod/crank ratio. No other type except, of course, the radial engine with very many cylinders can compare with these in this particular respect. On the other hand, experience has taught us that the opposed-cylinder type is particularly prone to broken crankshafts, while it is notorious that about the most difficult problem that a designer has to face is to eliminate critical speeds from a six-cylinder engine.

* A paper read before the Institution of Automobile Engineers, by F. A. Stepney Acres.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 77 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 3 14	13 3 0	1 0 2 14	1 7 2 0	1 14 1 14	2 1 1 0	2 8 0 14	2 15 0 0	3 1 3 14	0
1	0 2 21	7 2 7	14 1 21	1 1 1 7	1 8 0 21	1 15 0 7	2 1 3 21	2 8 3 7	2 15 2 21	3 2 2 7	1
2	1 1 14	8 1 0	15 0 14	1 2 0 0	1 8 3 14	1 15 3 0	2 2 2 14	2 9 2 0	2 16 1 14	3 3 1 0	2
3	2 0 7	8 3 21	15 3 7	1 2 2 21	1 9 2 7	1 16 1 21	2 3 1 7	2 10 0 21	2 17 0 7	3 3 3 21	3
4	2 3 0	9 2 14	16 2 0	1 3 1 14	1 10 1 0	1 17 0 14	2 4 0 0	2 10 3 14	2 17 3 0	3 4 2 14	4
5	3 1 21	10 1 7	17 0 21	1 4 0 7	1 10 3 21	1 17 3 7	2 4 2 21	2 11 2 7	2 18 1 21	3 5 1 7	5
6	4 0 14	11 0 0	17 3 14	1 4 3 0	1 11 2 14	1 18 2 0	2 5 1 14	2 12 1 0	2 19 0 14	3 6 0 0	6
7	4 3 7	11 2 21	18 2 7	1 5 1 21	1 12 1 7	1 19 0 21	2 6 0 7	2 12 3 21	2 19 3 7	3 6 2 21	7
8	5 2 0	12 1 14	19 1 0	1 6 0 14	1 13 0 0	1 19 3 14	2 6 3 0	2 13 2 14	3 0 2 0	3 7 1 14	8
9	6 0 21	13 0 7	19 3 21	1 6 3 7	1 13 2 21	2 0 2 7	2 7 1 21	2 14 1 7	3 1 0 21	3 8 0 7	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6·42	12·84	19·26	25·68	1 4·10	1 10·52	1 16·94	1 23·6	2 1·78	2 8·2	2 14·62	2 21	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 77 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 8 3 0	6 17 2 0	10 6 1 0	13 15 0 0	17 3 3 0	20 12 2 0	24 1 1 0	27 10 0 0	30 18 3 0	0
10	0 6 3 14	3 15 2 14	7 4 1 14	10 13 0 14	14 1 3 14	17 10 2 14	20 19 1 14	24 8 0 14	27 16 3 14	31 5 2 14	10
20	0 13 3 0	4 2 2 0	7 11 1 0	11 0 0 0	14 8 3 0	17 17 2 0	21 6 1 0	24 15 0 0	28 3 3 0	31 12 2 0	20
30	1 0 2 14	4 9 1 14	7 18 0 14	11 6 3 14	14 15 2 14	18 4 1 14	21 13 0 14	25 1 3 14	28 10 2 14	31 19 1 14	30
40	1 7 2 0	4 16 1 0	8 5 0 0	11 13 3 0	15 2 2 0	18 11 1 0	22 0 0 0	25 8 3 0	28 17 2 0	32 6 1 0	40
50	1 14 1 14	5 3 0 14	8 11 3 14	12 0 2 14	15 9 1 14	18 18 0 14	22 6 3 14	25 15 2 14	29 4 1 14	32 13 0 14	50
60	2 1 1 0	5 10 0 0	8 18 3 0	12 7 2 0	15 16 1 0	19 5 0 0	22 13 3 0	26 2 2 0	29 11 1 0	33 0 0 0	60
70	2 8 0 14	5 16 3 14	9 5 2 14	12 14 1 14	16 3 0 14	19 11 3 14	23 0 2 14	26 9 1 14	29 18 0 14	33 6 3 14	70
80	2 15 0 0	6 3 3 0	9 12 2 0	13 1 1 0	16 10 0 0	19 18 3 0	23 7 2 0	26 16 1 0	30 5 0 0	33 13 3 0	80
90	3 1 3 14	6 10 2 14	9 19 1 14	13 8 0 14	16 16 3 14	20 5 2 14	23 14 1 14	27 3 0 14	30 11 3 14	34 0 2 14	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	34 7 2 0	68 15 0 0	103 2 2 0	137 10 0 0	171 17 2 0	206 5 0 0	240 12 2 0	275 0 0 0	309 7 2 0	343 15 0 0	

COMPILED AND ARRANGED BY T. E. WOODHOUSE

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 76 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 3 4	13 2 8	1 0 1 12	1 7 0 16	1 13 3 20	2 0 2 24	2 7 2 0	2 14 1 4	3 1 0 8	0
1	0 2 20	7 1 24	14 1 0	1 1 0 4	1 7 3 8	1 14 2 12	2 1 1 16	2 8 0 20	2 14 3 24	3 1 3 0	1
2	1 1 12	8 0 16	14 3 20	1 1 2 24	1 8 2 0	1 15 1 4	2 2 0 8	2 8 3 12	2 15 2 16	3 2 1 20	2
3	2 0 4	8 3 8	15 2 12	1 2 1 16	1 9 0 20	1 15 3 24	2 2 3 0	2 9 2 4	2 16 1 8	3 3 0 12	3
4	2 2 24	9 2 0	16 1 4	1 3 0 8	1 9 3 12	1 16 2 16	2 3 1 20	2 10 0 24	2 17 0 0	3 3 3 4	4
5	3 1 16	10 0 20	16 3 24	1 3 3 0	1 10 2 4	1 17 1 8	2 4 0 12	2 10 3 16	2 17 2 20	3 4 1 24	5
6	4 0 8	10 3 12	17 2 16	1 4 1 20	1 11 0 24	1 18 0 0	2 4 3 4	2 11 2 8	2 18 1 12	3 5 0 16	6
7	4 3 0	11 2 4	18 1 8	1 5 0 12	1 11 3 16	1 18 2 20	2 5 1 24	2 12 1 0	2 19 0 4	3 5 3 8	7
8	5 1 20	12 0 24	19 0 0	1 5 3 4	1 12 2 8	1 19 1 12	2 6 0 16	2 12 3 20	2 19 2 24	3 6 2 0	8
9	6 0 12	12 3 16	19 2 20	1 6 1 24	1 13 1 0	2 0 0 4	2 6 3 8	2 13 2 12	3 0 1 16	3 7 0 20	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6.34	12.68	19.02	25.36	1 3.70	1 10.04	1 16.38	1 22.72	2 1.06	2 7.40	2 13.74	2 20	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 76 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 7 3 12	5 15 2 21	10 3 2 8	13 11 1 20	16 19 1 4	20 7 0 16	23 15 0 0	27 2 3 12	30 10 2 24	0
10	0 6 3 4	3 14 2 16	7 2 2 0	10 10 1 12	13 18 0 24	17 6 0 8	20 13 3 20	24 1 3 4	27 9 2 16	30 17 2 0	10
20	0 13 2 8	4 1 1 20	7 9 1 4	10 17 0 16	14 5 0 0	17 12 3 12	21 0 2 24	24 8 2 8	27 16 1 20	31 4 1 4	20
30	1 0 1 12	4 8 0 24	7 16 0 8	11 3 3 20	14 11 3 4	17 19 2 16	21 7 2 0	24 15 1 12	28 3 0 24	31 11 0 8	30
40	1 7 0 16	4 15 0 0	8 2 3 12	11 10 2 24	14 18 2 8	18 6 1 20	21 14 1 4	25 2 0 16	28 10 0 0	31 17 3 12	40
50	1 13 3 20	5 1 3 4	8 9 2 16	11 17 2 20	15 5 1 12	18 13 0 24	22 1 0 8	25 8 3 20	28 16 3 4	32 4 2 16	50
60	2 0 2 24	5 8 2 8	8 16 1 20	12 4 1 4	15 12 0 16	19 0 0 0	22 7 3 12	25 15 2 24	29 3 2 8	32 11 1 20	60
70	2 7 2 0	5 15 1 12	9 3 0 24	12 11 0 8	15 18 3 20	19 6 3 4	22 14 2 16	26 2 2 0	29 10 1 12	32 18 0 24	70
80	2 14 1 4	6 2 0 16	9 10 0 0	12 17 3 12	16 5 2 24	19 13 2 8	23 1 1 20	26 9 1 4	29 17 0 16	33 5 0 0	80
90	3 1 0 8	6 8 3 24	9 16 3 4	13 4 2 16	16 12 2 0	20 0 1 12	23 8 0 24	26 16 0 8	30 3 3 20	34 11 3 4	90

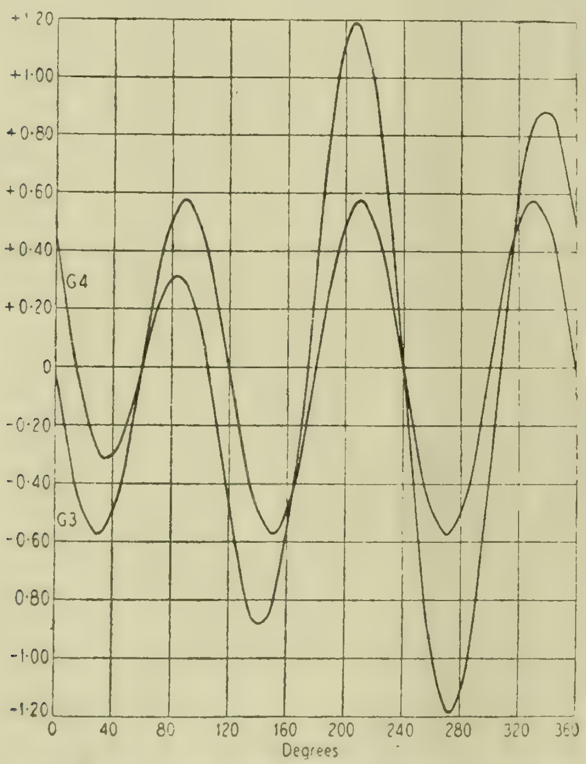
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	33 18 2 8	67 17 0 16	101 15 2 24	135 14 1 4	169 12 3 12	203 11 1 20	237 10 0 0	271 8 2 8	305 7 0 16	339 5 2 24	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Complex as the question of balancing appears to be, complete investigation of the internal stresses set up by inertia are still more so owing to their varied nature. The great majority of members will be quite familiar with the evaluation of connecting rod stresses due to inertia, and big and small end bearing pressures from the same source. The question of main bearing pressures was fully dealt with in a paper before the Society of Automobile Engineers of America, and published in *The Automobile Engineer* for March, 1918, in which the effects of balance weights on bearing pressures are shown by a very complete series of diagrams.

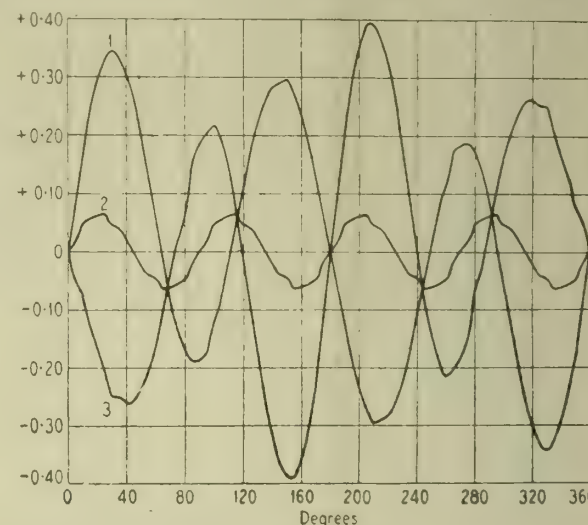
The particular effect of inertia to which the author now wishes to draw attention is that which, for want of a better name, he has called inertia torque, that is to say, the torque transmitted through the crankshaft to effect the alternate acceleration, and



Journals 3 and 4 of six-cylinder engine. Journal 1 is, of course, the same as a single-cylinder or Journal 1 of a four-cylinder engine.

deceleration of the piston and connecting rod, with the consequent rapid alternation of stress in the crankshaft, the maximum values and frequency of which vary considerably with different cylinder arrangements. It will be seen also in due course that these may vary from journal to journal of a multi-cylinder engine in a most extraordinary fashion, a fact which may reasonably be expected to have a considerable effect on the behaviour of an engine, quite apart from any question of balance, and in this connection it is interesting to notice that certain types which give the best linear balance are the worst in respect to this inertia torque and consequent reaction. One example of this is the "flat-twin" already referred to. Or again, if we could make a four-cylinder engine with the mechanical equivalent of an infinite connecting rod we should obtain perfect linear balance in every direction, and yet the rotary reaction would only be about 1 per cent less than with a four to one connecting rod/crank ratio.

To deal with this subject properly, it is almost impossible to avoid a certain amount of familiar

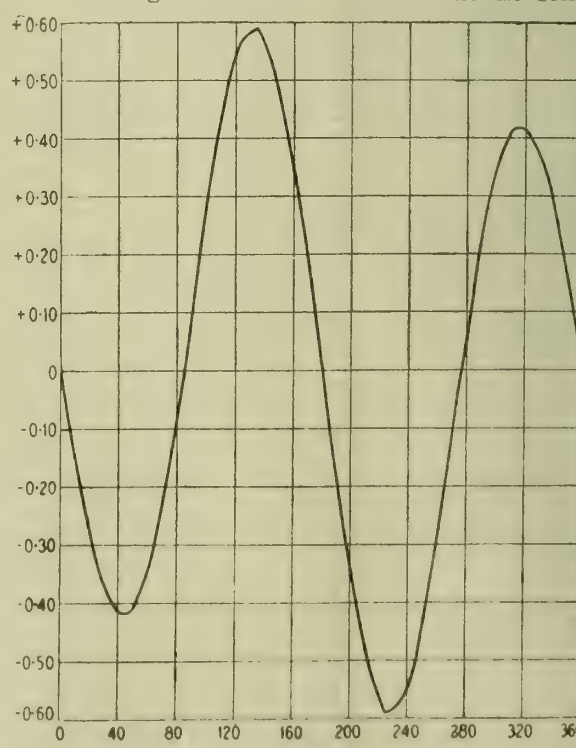


Journals 1, 2, 3 of eight-cylinder Vee 90 degrees. Journal 4 is twice Journal 2.

ground, and therefore the author must beg members to bear with him patiently if at times he appears to transgress in this way.

Definitions.

At this stage it will be as well to define some of



The peak Value of K is 0·590, as compared with 0·650 in a single-cylinder engine. The frequency is the same as a single cylinder engine.

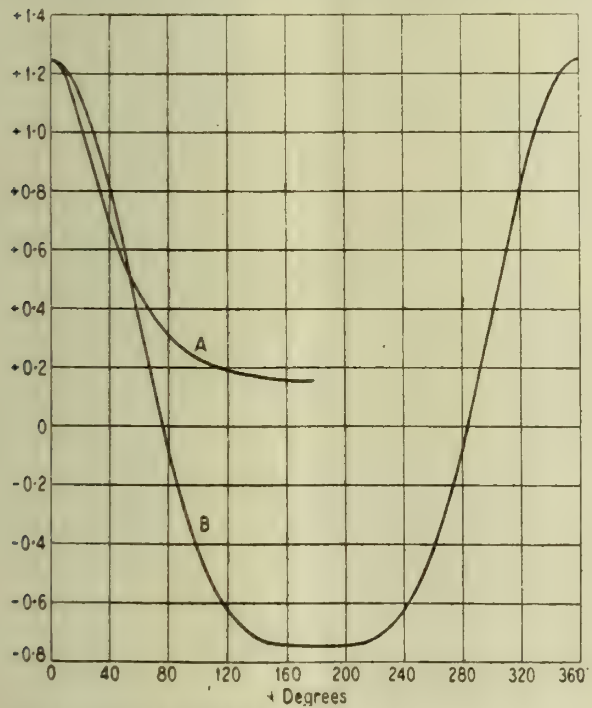
Vee twin-cylinder at 60 degrees.

the terms and notation used in this paper in order to avoid possible confusion.

Inertia torque has just been defined as the torque transmitted through the crankshaft to overcome the

inertia of the reciprocating parts. It is because we have to fit a flywheel to maintain a practically constant speed of revolution that this torque is created, and it will be obvious that the torque due to any one line of reciprocating parts in a multi-cylinder engine is transmitted through the whole of the crankshaft between the point of application of the load (*i.e.*, the corresponding crank pin) and the flywheel, and therefore in the ordinary arrangement of engine each journal is subject to the algebraic sum of the torques transmitted to or from each crank pin in front of it, that is, further from the flywheel; for example, in a six-cylinder engine with seven bearings, the journal between the fifth and sixth cylinders is subjected to the combinations of torque due to the reciprocating parts of all the cylinders Nos. 1 to 5. This inertia torque therefore is quite distinct from the rotary reaction which is used to imply the net resultant on the engine as a whole, and which is equal and opposite to the torque in the journal between the last cylinder and the flywheel.

In order to be able to evaluate a definite series of

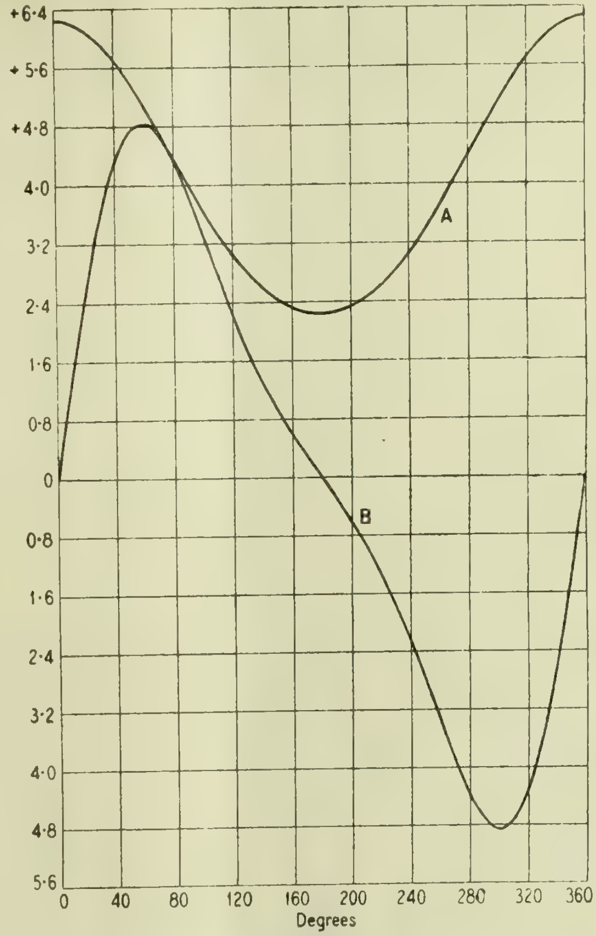


Curve A. = Value of C when R/L = 1/4.
Curve B.—Shows form of expansion curve corrected to crank angles. If peak explosion pressure equals inertia force at top of stroke, the intercepts between the two curves would represent (to a certain scale) the resultant force acting on small end. It will be seen that up to about 60 degrees these intercepts are small, being negative up to 52 degrees, that is to say effective work is only being done during approximately the latter half of the stroke.

FIG. 1.

curves, the author has assumed that the coefficient of speed variation is zero. This, of course, is not strictly accurate, but is the only possible basis on which to start. It should be pointed out that this variation is dependent on the ratio between rotating and reciprocating weights, and is independent of the actual velocity.

On this assumption it is clear that the torque is due solely to the weight of the purely reciprocating parts, that is to say, the piston complete with rings and the gudgeon pin plus the small end of the connecting rod, and that is in no way due to the big end of the rod or to balance-weights when fitted, since their velocity of rotation is uniform, and a torque of the nature to be considered here can only be set up by a change of velocity, inertia force being a product of mass by acceleration. Certainly there is a small force set up by the oscillation of the rod, but it is proposed to ignore this since it is a function of half the weight of the body of the rod between the big and small ends, a weight which in automobile and aero practice is practically negligible.



Curves are as follows:—A. Centrifugal tension in connecting rod.
B. Inertia torque.

FIG. 2.

As regards notation, the following symbols are used throughout:—

W = The weight in pounds of a single line of purely reciprocating parts as already defined.

f = The linear acceleration in feet per second per second of this weight along the cylinder centre line at the particular point in the stroke corresponding to

ϕ = The angular displacement of the crank from the top centre.

In the diagrams set out for the case of Vee engines, ϕ is measured from the centre line of the Vee, while in the case of the rotary engine it represents the displacement of a cylinder centre line from the crank centre.

θ = The corresponding angle of connecting rod with the cylinder centre line.

R = The radius of the crank throw in inches (half the stroke).

L = The length of the connecting rod in inches.

ω = The angular velocity of the crank or cylinder in radians per second, and is equal to $\pi.2.N/60$ where

N = The number of revolutions per minute.

I = The linear inertia force along the cylinder centre line and is equal to $W.f/g$, g being the gravity constant.

T = The torque set up in the crankshaft by the force I, which will be shown to be equal to $I.R. \sin(\theta+\phi)/\cos\theta$.

C and K are inertia force and inertia torque constants, which it is desired to evaluate and of which a clear definition can only be given when they arise.

(*To be continued.*)

WATER POWER DEVELOPMENT.

(*Concluded from page 263*).

The great problem of to-day is to avoid destroying coal, thereby proportionately saving life, and find openings in new and more desirable fields of labour.

Now, water power, which had almost been relegated to obscurity by the perfection of steam plant, is not only gaining by force of circumstances, but is now getting a real move on by the Government, who intend bringing this to the front as a prime source of economical power.

It would not be going too far to say that a well-conditioned hydro-electrical power plant can successfully compete with the most refined steam plant and the lowest priced fuel, even natural or blast-furnace gas, two of the cheapest fuels known.

In the past, coal was cheap and abundant, therefore the necessity for extracting and utilising the last ounce of heat and energy was not of the supreme importance it is to-day. Now, conditions are changed, costs increased—more than doubled—supplies strictly limited, and this state of things is bound to persist.

When coal was 10s. a ton, a 10 per cent economy was not considered of much importance on capital outlay in new plant; considering coal now averages 35s. per ton, 10 per cent efficiency would now be of considerable importance.

As pointed out, the true economical method of dealing with this valuable asset is to extract, on the most efficient system, all its valuable bye-products, thereby reducing waste to an irreducible minimum, and thereby obtaining power purely as a bye-product.

It is an elementary law of economics that a universal demand and a limited supply, as is the case to-day, is the direct sequence of its ruling high price.

Cheap power production is a vital necessity of any manufacturing nation, and water power is the only medium that truly meets this requirement. The subject is, therefore, of direct interest to every power user, and considered, from a national point of view, of supreme importance to every person in this country.

The coal miners or rather their leaders, are demanding the nationalisation of the coal industry; they have declared that they will stop production if demands are not granted. This is a deplorable condition; however, there can be no turning off the tap with water power.

Modern transport and production are carried on by machinery which is set in motion by electrical power, by steam raised by coal or oil. It is assumed this country has no water power of importance, as exists in France, Italy, Germany, and the States, and as oil has to be imported at great expense, therefore the prosperity of this country has hitherto depended on coal. If this state of affairs is going to continue, it will assuredly be a bad look-out for this country.

Scarcity and consequent dearness of coal is inconvenient to private consumers; it is absolutely ruinous to trades and industries whereby the nation lives. Scarce and dear coal hampers the production and sale of all commodities to the private consumer; it means dear fuel, dear gas, dear travelling, dear freights, dear clothes, dear boots, dear bricks, and dear houses.

In the States water power is going strong, and the output per miner is rapidly increasing; it is practically three times that of an English miner. This increase is principally due to improved machinery. The shrinkage in this country is due to a ca' canny policy to make coal scarce to increase wages.

The Royal Commission sitting on coal supplies in 1905 stated, if all the available water power in this country was used, it would only save 1,200,000 tons of coal yearly.

This is additional proof of the erroneous ideas concerning water power in this country. There is no dodging the fact that water power furnishes a cheap and inexhaustible subsitute for coal. This, coupled with other prime advantages, makes the engineer-in-charge of a steam driven plant at times use strong, unpolite language at his boilers, pumps and engines, and cast envious longings at his hydro-electric brother who is never worried by bad coal or low pressure.

It may be assumed that the cost of steam produced current at the average public generating station now costs $1\frac{3}{4}$d. the unit, as against water power at $\frac{5}{8}$ of a 1d.

The highest water fall in the world is the Yosemite fall in California; here the descent is 2,600 ft. in three successive stages.

The broadest fall in the world is the Iguassu fall in South America; it is two miles broad, with a head of 213 ft., and is estimated to give 14,000,000 H.P.

The fall where it would be possible to obtain the greatest power is at the Victoria falls on the Zambesi River, where it is estimated 35,000,000 H.P. could be had; the lip of the fall is over a mile, and has a drop of 386 ft.

The most remarkable development of water power, considering low head and flatness of district, is the Keskuk barrier thrown across the Mississippi River. The working head is 32 ft.; the gradient in river bed is under 2 ft. to the mile, still it is possible to obtain 300,000 H.P. here.

At Hedley, a gold-mining town in British Columbia, electricity is obtained so cheaply by water power that the inhabitants never bother to turn off the lights, they are left burning all night in shops and houses.

At Greenfield, Mass., U.S.A., an hydro-electric plant runs 23 hours out of the 24 without any attendant.

The balance sheet of the Albama River Co. shows that the man power required in a steam plant is $13\frac{1}{2}$ to the 1,000 kws. capacity, whereas, in the hydro-electric plant of same company and like capacity, the comparative figure is less than $\frac{1}{3}$ of a man for making white liquid coal to do the work of black diamonds.

(Concluded.)

HEAT APPLIED TO ENGINEERING.

By PROF. W. W. HALDANE GEE, B.Sc., M.Sc.Tech.

(Continued from page 206.)

Photometer Pyrometers.

In the radiation pyrometers already discussed the measurement of temperature depends on the total radiation emitted from the heated body. When the temperature is sufficiently high as to emit luminous energy, then a method of pyrometry based upon light alone is possible. This is the principle of one of the oldest method of judging temperatures. A practised workman can give a good guess of the temperature of hot iron from its appearance. Pouillet attempted the task of standardising the method by measuring, with an air thermometer, the temperatures corresponding to a scale of colours. His results are shown in the table:

TEMPERATURE COLOUR SCALE.

	°C.
First visible red	525
Dull red	700
Turning to cherry red	800
Cherry red	900
Bright cherry red	1000
Dull orange	1100
Bright orange	1200
White	1300
Brilliant white	1400
Dazzling white	1500

With the higher temperatures the error of estimation may be as high as 200°, but with the red colours the judgment is more precise, and the error may be less than 25°, if the observation be made in a dark room.

An instrument designed to measure temperatures by the comparison between the illumination given by the heated body with a standard light may be called a *photometric pyrometer.* The construction of that of Holborn and Kurlbaum will be easily understood. It consists of a telescope having a small 4-volt electric incandescent lamp mounted within it so that it can be viewed by the eyepiece. When the telescope is directed to the heated object an image is produced in the same plane as the lamp filament. By means of a rheostat the current through the lamp is adjusted until the tip of the filament can no longer be seen against the image of the hot source, which latter has now the same colour and brightness as the heated filament. The point of balance is directly obtained with temperatures below 800°, but for higher values it is advisable to interpose one or two pieces of monochromatic red glass in front of the eyepiece. At very high temperatures, to avoid over-running the lamp, coloured absorbing glasses must be placed in front of the telescope field lens. The temperature is ascertained by calibrating a milliammeter included in the lamp circuit. To do this the telescope is sighted on a heated black body, whose temperature is ascertained by the use of a thermo-junction. The question may be asked: How far can the lamp be depended upon to give the same light for a definite current? This point has received careful attention. It is found essential that the lamp should be "aged"; that is, it must be used for some time at a higher temperature than it will be submitted to in the pyrometer.

Wien's Law.

It will now be necessary to discuss the connection between the intensities of the radiant beams and the temperatures of the hot bodies, which are supposed to be perfectly black, from which the light is emitted. Here we are much indebted to W. Wien, who since 1898 has contributed much to the science of radiant energy. One of the laws he deduced gives the

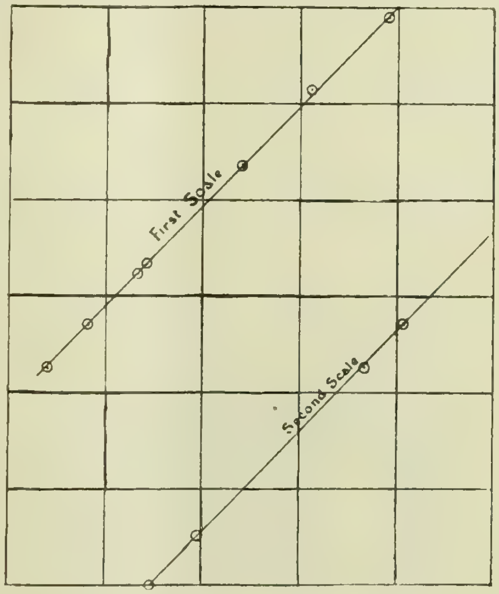


FIG. 5.—TEST OF PYROMETER LAW

intensity I in terms of the wave length λ, the absolute temperature T, and two constants k_1 and k_2:

$$I = \frac{k_1}{\lambda^5} e^{-k_2 \lambda T}$$

For a constant wave length as is used in this pyrometer, the above expression may be simplified:

$$I = K_1 e^{-K_2 T}$$

K_1 and K_2 being now constants.

For two intensities I_1 and I_2 the photometric law used gives:

$$\frac{I_1}{I_2} = \frac{\tan^2 \phi_1}{\tan^2 \phi_2}$$

ϕ_1 and ϕ_2 being angles measured by the pyrometer, when T_1 and T_2 are the corresponding absolute temderatures we deduce from Wien's law:

$$\frac{I_1}{I_2} = e^{K_2(1/T_2 - 1/T_1)}.$$

Hence taking the logarithms:

$$2\,(\log \tan \phi_1 - \log \tan \phi_2) = K_2(1/T_2 - 1/T_1).$$

From which we deduce that the relation between an angle ϕ and an absolute temperature T as:

$$\log \tan \phi = a + \frac{b}{T}$$

a and b being constants. Hence, if we plot log tan ϕ against the reciprocal of T, a straight line should be obtained, if the above theory is correct. Messrs. E. Griffiths and F. H. Schofield (Faraday Society, 1917) have tested this relation for a pyrometer and have obtained the straight lines shown in Fig 5. The instrument was provided with two scales; the higher one required the insertion of a neutral tinted glass in the path of the radiation. It will be noticed that the lines are parallel, and the second scale extended the readings to very high temperatures. Fig. 6 shows the relation between the angle and the temperature for the scale extending from 700° to 1400°C. Instruments are made to read as high as 4000°C., which is above the temperature of the electric arc. Up to 1400°C. the standardisation can be effected with a thermo-junction.

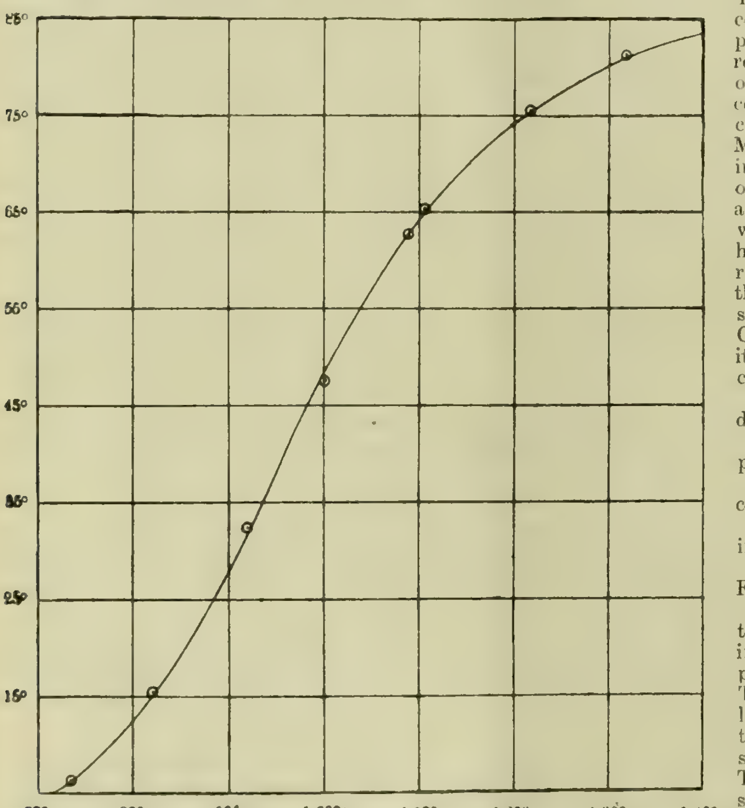


Fig. 6.—Graph of Pyrometer Angle and Temperature

The Hefner Standard.

In Wanner's pyrometer, a small 4-volt is used for the comparison light, but instead of varying the intensity of the light by a rheostat—as in the Holborn and Kurlbaum pyrometer—it is kept at a constant brightness throughout the tests. This is tested periodically by the direct comparison with a standard amyl acetate lamp. This type of lamp was the invention of F. von Hefner-Alteneck in 1884, and is generally known simply as the "Hefner lamp." An extended investigation carried out by the Physikalische Reichanstalt led to the standardisation of the lamp in Germany for photometric work. Amyl acetate is of considerable importance in commerce; it is used for producing a flavouring like that of Jargonelle pears and as a solvent for celluloid. For photometric purposes it must be quite pure, and should be stored in glass-stoppered bottles in a dark place. It burns with a flame of reddish colour, which for the purpose of pyrometry is not of disadvantage. As designed by the Reichanstalt, the lamp is of brass, with a German-silver wick tube. The wick is circular, and can be fed by a worm gearing. It is most essential to have the flame of a standard height of 40 mm. To secure this a sighting device is provided. After lighting the lamp it is necessary to wait about 10 minutes, and then carefully to adjust the flame height, for an error of 1 mm. in height of the flame produces a 3 per cent. error in the light.

(*To be continued.*)

STEAM TABLES.*

These tables have been prepared to supply, in a compact form, convenient for practical use, the information concerning the properties of steam, both saturated and superheated, which is required in connection with the work of the boiler. The intention of the compiler was not to supersede existing tables, nor does he consider the present series an improvement upon such admirable collections as (for instance) those of Prof. Peabody or of Messrs. Marks and Davis. But, for the calculations particularly necessary in boiler-house practice, including the working out of the results of boiler tests, these general collections present certain disadvantages. A number of columns are included, giving properties with which the boiler man is not concerned, and, on the other hand, some figures must be got by calculation from the tabular results which it is worth while to have presented directly For these reasons the present compilation was undertaken. It has for some time been in use in the offices of Messrs. Ed. Bennis and Co. Ltd., and the experience there gained leads us to hope that it will be of some advantage to our readers that we give it a wider circulation in *Cheap Steam*.

The special features of the present compilation may be briefly described. The properties of steam tabulated are :—

(1) Saturation temperature, corresponding to given gauge pressures;

(2) Total heat of saturated steam above water at 32 deg. Fah., corresponding to given gauge pressures;

(3) Total heat of water above water at 32 deg. Fah., corresponding to given temperatures;

(4) Factors of equivalent evaporation as from and at 212 deg. Fah., corresponding to given actual conditions of evaporation.

It has been found advantageous to devote the whole of one table to each of these four properties, instead of putting them into separate columns of a general table. In this arrangement the property with which the table is entered (gauge pressure in Tables 1 and 2, temperature in Table 3) is given as in an ordinary logarithm table, the units figure being placed at the head of the ten columns, and the hundreds and tens figures beginning the successive lines and forming the left-hand column of the table. This arrangement is well-known, and combines compactness with simplicity. For example, to find the saturation temperature of steam at 197 lb. per square inch gauge pressure, Table 1 is entered on line 19 and in the column headed 7, when the result, 386·70, is found.

The first three tables are arranged as just described; but the table of evaporation factors presented a more complicated problem. In this case the factor required depends, not upon only one given quantity as in the other cases, but upon three, namely, gauge pressure, feed-water temperature, number of degrees of superheat. As is well known, a double entry table, depending on two given quantities, is troublesome to consult, and yet more so when interpolation is necessary. A triple entry table would be altogether impracticable. It has therefore been decided to divide the table of evaporation factors into three parts. Each part gives the component of the required evaporation factor depending upon one of the three properties mentioned above, and by adding the figures obtained from the three parts of the table the evaporation factor is got. The necessity for this addition is, of course, a disadvantage, but it has been found in use that this disadvantage is more than counterbalanced by the fact that the arrangement adopted permits values to be given for each successive unit, within its range, of each of the properties concerned, pressure, feed temperature, superheat. Thus, accurate results are given without troublesome resort to interpolation.

* Specially prepared by Ed. Bennis and Co. Ltd., and published in their journal "Cheap Steam."

The three parts of the table of evaporation factors are headed 4(*a*), giving the figure corresponding to the gauge pressure of steam; 4(*b*), giving the figure corresponding to the feed-water temperature; 4(*c*), giving the figure corresponding to the number of degrees of superheat in the steam. An example will make clear the method of using this table. If a boiler receives water at 114 deg. Fah and evaporates it into steam at a gauge pressure of 216 lb. per square inch, the steam being superheated to 126 deg. Fah. above the saturation temperature corresponding to the pressure, what is the evaporation factor? Entering Tables 4(*a*), 4(*b*), 4(*c*) successively, we get the following results:—

Table 4(*a*),	position 216, gives	23744
Table 4(*b*),	position 114, gives	91544
Table 4(*c*),	position 126, gives	07147
Add; evaporation	factor	= 1·22435

It should be noted that the figures given in the three parts of Table 4 are decimals. In Table 4(*b*) the entry corresponding to 32 deg. Fah. is 1·00000. This figure is not printed in order to avoid the possibility of error being caused by the occurrence of 1 in the units placed in that one entry; but as feed water at 32 deg. is never met with in practice, the omission is unimportant. When consulting Table 4(*c*), for supreheated steam, it must be remembered that the temperature with which that table is entered is not the temperature of steam leaving the superheater, but the number of degrees of superheat. Therefore, if, in a given case, the data include the steam pressure and the temperature of the superheated steam, it is necessary, before referring to Table 4(*c*), to determine the number of degrees of superheat by subtracting from the given temperature the saturation temperature corresponding to the given pressure. This latter temperature is given in Table 1. As an example, suppose that steam at 100 lb. per square inch gauge pressure is superheated to 400 deg. Fah. Table 1, position 100, gives 337·94 as the saturation temperature, and this figure, subtracted from 400, gives 62·06, which is the number of degrees of superheat in the case given. Thus, to get the evaporation factor, Table 4(*c*) must be entered with 62·06, and not with 400. In Table 4 the intervals of pressure and of temperature are so small that it is usually quite sufficiently accurate to take the nearest whole numbers, without interpolation. If, however, it is desired to use interpolation, it can be done in the usual manner, remembering that the differences in Table 4(*b*) are subtractive. Each part of Table 4 would be corrected independently. In Table 4(*b*) the difference is nearly constant at −103; this is so near to 100 that interpolation can be readily effected by subtracting the decimals (adding a 0 if there is only one decimal) from the entry corresponding to the whole degrees. Thus for T=172 the entry in Table 4(*b*) is 85563; if the temperature given were 172·48, the corrected figure would be 85515. In Table 4(*c*), since the entries are constant multiples of the number of degrees of superheat, the correction for fractions of degrees can be found in the table itself by striking off the last two figures of the entry corresponding to the decimal (regarding this as a whole number) and adding the remaining figures, transferred to the fourth and fifth places. Thus, if S=172·48, position 48 gives entry 02722; strike off the 22 then 27 is the required correction: adding this to 09756 (the entry in position 172) gives 09783 as the exact figure corresponding to S=172·48. But these refinements are very seldom wanted; the use of a different steam table will make more difference in the evaporation factor than the neglect of interpolation in these tables. And even the best modern tables cannot claim an accuracy above one per thousand anywhere, and it is considerably less over much of their range.

(*To be continued.*)

CAM GRINDING AND THE GRINDING OF IRREGULAR SHAPES.

By H. B. Lindsay.

The camshafts of American automobile engines have been designed by men who rely upon Norton grinding equipment to reproduce in metal with great exactness and economy the contours required for quiet, efficient operation of the motor. The tendency in cam design is toward small clearances and low valve seating velocities, which means greater attention to "quieting curves," and a still more exacting demand of the cam grinding machine. These requirements have been anticipated, with the result that Norton cam grinding equipment will continue to be standard in the largest automobile plants in this country and abroad. In addition to the usual type of loose cams and integral camshafts, there are

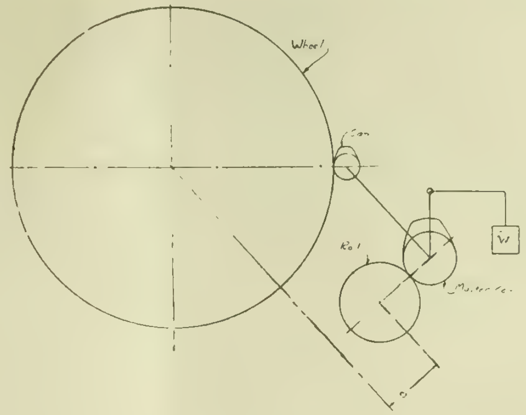


Fig. 1.

many eccentric shapes combining tangential and curved outlines which are being produced in quantities on cam grinding attachments.

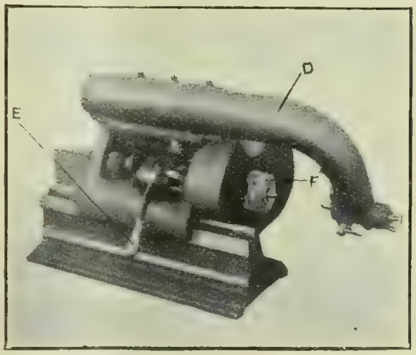


Fig. 2.—Front View.

The principles of the operation are shown in Fig. 1 where the master cam, follower roll, grinding wheel, and cam are illustrated diagrammatically

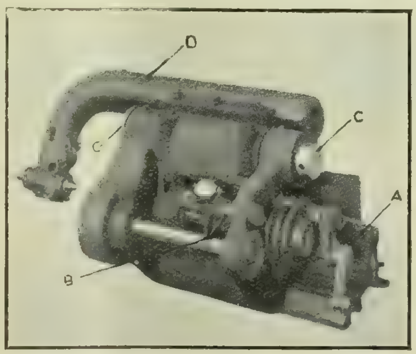


Fig. 3.—Rear View.

"W" represents a weight or spring arranged to keep the master cam in contact with the roll. The distance "B" between wheel centre and roll centre is variable to allow the wheel to be fed into the work.

The number 2 loose cam grinding attachment is shown in Figs. 2 and 3. Motion is transmitted to the attachment by the headstock through the crank at "A." The hardened master cam, which produces the desired shape on the cam blank is mounted at "B," and the attachment oscillates on the trunnions "C." The cam blank is mounted on the centres and is supported by the overhanging arm "D." Means are provided for lifting the work away from the grinding wheel by lever "E." The cam is driven by dog "F," proper speeds being obtained through the regular speed change mechanism in the headstock of the grinding

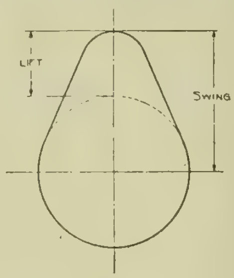


Fig 4.

machine. The several attachments have capacities in swing of $1\frac{5}{8}$ in., $2\frac{7}{8}$ in., 5 in., and 7 in. and in lift of $\frac{3}{4}$ in., $1\frac{3}{8}$ in., $1\frac{1}{2}$ in., and 3 in. (see Fig. 4), and are adapted for use on the 10 in., 14 in., and larger Norton cylindrical grinding machines.

The integral cam grinding attachment, which takes its name from the style of cams it is designed to grind, is illustrated in Figs. 5 and 6. Two types and two sizes are manufactured, the two types differing only in the method of driving, one getting its power through the headstock of the machine, whereas the other is belted direct from overhead. Both

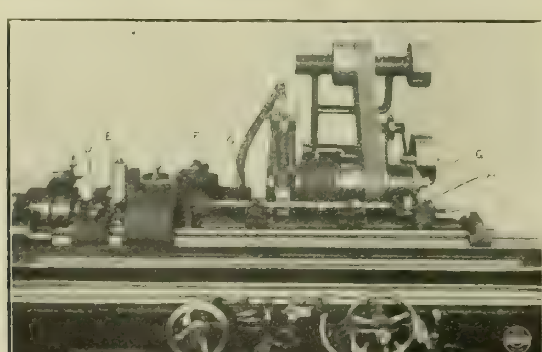


Fig. 5. – Integral Cam Grinding Attachment.

have their advantages. Where a variety of work is to be done, the first is recommended, as it is possible by simply removing the attachment from the table of the machine to handle any form of cylindrical grinding. In the latter case, the head and footstock of the machine are omitted, and the attachment occupies the entire table surface (making possible a shorter machine), and is confined to the grinding of camshafts where large quantities are required. In size the attachments are capable of swing 2 in. and $2\frac{3}{16}$ in., with a lift of $\frac{7}{16}$ in. and $\frac{3}{4}$ in. (see Fig. 4), and will handle camshafts up to 58 in. overall length, having from one to 14 cams to be ground. They are adapted for use on 10 in., 14 in., and larger machines.

Fig. 5 shows the attachment on the machine in operating position; Fig. 6 is a nearer view of the rear of the headstock end of the attachment. "A" is the driving arm; "B" the master cams on the

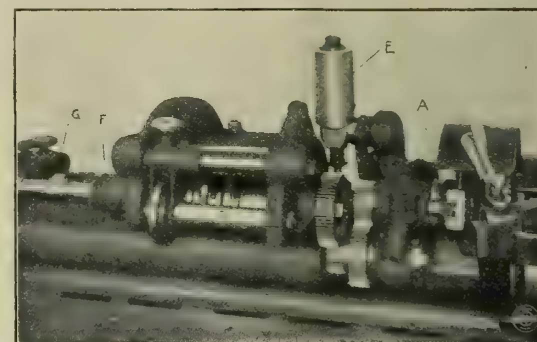


Fig. 6.—Rear View Showing Master Cams and Follower Rolls.

master cam spindle; "C" the roll which is quickly located before the proper cam by sliding along shaft "D." "E" is the encased spring which holds the master cam snugly against the roll. "F" shows the driving dog in position; "G" the steady-rests; and "H" the footstock, which is movable to allow for different lengths of camshafts, which are carried on the centres of the attachment.

Cam Grinding.

Smooth, efficient engine performance is largely dependent upon camshaft design, but unless the countours laid out by the designer are reproduced faithfully in the metal, his purpose will have been defeated.

Integral camshafts are roughed from the black forging, removing from 0·030 in. to 0·125 in. stock; the wheel recommended for this operation, for use with Norton equipment, is Grain 24 Combination, Grade O, Alundum Vitrified. If harder grades are used for roughing, the roll may not follow the master cams accurately and, although the production at this stage will show an increase over that of the softer wheel, the finishing operation is pro-

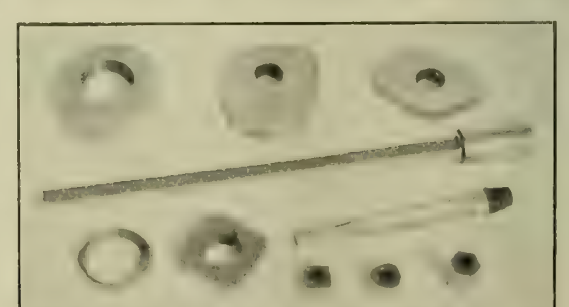


Fig. 7.—Irregular Shapes Ground on Norton Cam Grinding Attachment.

longed by the necessity of correcting the errors of contour introduced in the effort to rough at a high rate.

After hardening, the finish grinding is often done in two steps, semi-finishing and finishing, without removing the shaft from the centres. Stock

removed varies from ·012 in. to ·020 in.; Norton grain 6630, grade K, and grain 3836, grade J, are suitable wheels for finishing.

In general, it may be said that production is largely in the hands of the operators. Two men, working at machines side by side in a large automobile plant, roughing (semi-finishing), and finishing eight-cylinder camshafts, have the same equipment and wheels; one man turns out six and the other nine shafts per hour. At an automobile plant in Detroit, eight-cam shafts are semi-finished and finished by one man at the rate of 14 per hour. This operator has been grinding cams for two years. Softening, checking, and chattermarks are defects which may arise from the use of wheels too hard for the work or from an attempt to crowd production above a point consistent with the requirements of finish and accuracy.

Other Uses for Cam Grinding Equipment.

Cam grinding equipment may be used for quantity production of irregular shapes such those illustrated in Fig. 7. The manner of grinding automatic pistol barrels is shown in Fig. 8. As the possibilities of this form of grinding are appreciated, many eccentric and non-cylindrical

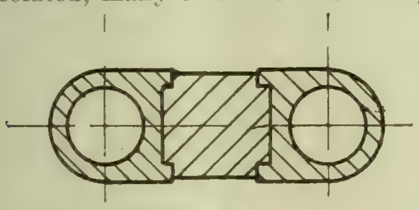


Fig. 8.

sections which are now laboriously milled will be ground with the same facility with which cylindrical and plain surfaces are already so universally produced by grinding machinery.

In approaching a new grinding problem of this character, the speed of work rotation, abrasive grain size, and grade of wheel must be chosen with more than usual care because there are likely to be variations from plain surface to small radius contacts in each revolution of the piece. Such operations should be undertaken only with the advice of competent grinding engineers. The grinding machine division of Norton Co. offers its services in this connection.

ADVERTISING IN THE ENGINEERING INDUSTRIES.

Manufacturers as Publishers.

At one time manufacturers of all classes employed on their own premises the machinery for producing power to drive the works. Originally, direct steam, gas or oil engine drive was the fashion, and subsequently the dynamo and motor intervened, furnishing a self-contained isolated electric plant. After a while the manufacturer discovered that his real object in life was not to generate electrical energy, but to make and dispose of some particular product. Like a wise man he then entrusted his electric power supply requirements to an outside authority, thereby acquiring for purposes of production the valuable land and buildings formerly called the power house.

In much the same way manufacturers will in time see that they are not in business as publishers and printers but strictly as producers. The change is coming slowly, but it is coming surely. It is being realised that the business pages of the recognised technical and trade papers represent a valuable means of publicity. An advertisement in an established journal has a "cachet" which no circular, pamphlet or piece of special trade literature sent through the post by any individual firm can possibly possess. The trade press has definite avenues of publicity represented by its regular subscribers and readers. If those readers, among whom will be many prospective buyers, are encouraged to look to the business pages of the trade press each week for the manufacturers' advertisement of his products, they will make a habit of turning there for the information desired. They will not expect to have a letterbox stuffed with circulars which, however highly coloured, or however bizarre, find their inevitable end in the w.p.b. In the industrial utopia the trade journal will be the principle intermediary between producer and buyer.

House Organs.

Whilst on the subject of manufacturers as publishers reference may be made to the little house organs which are now regularly issued by many manufacturing firms. Those who have experimented with this class of publicity usually speak highly of it. It is natural that a firm should have a feeling of pride not to say a pretty conceit with its own affairs. This feeling of interest, it is presumed, will also be shared by present and prospective customers. Undoubtedly the house organ promotes good fellowship amongst the staff and employees, but there is a real difficulty to be faced as editors of these publications will agree. The magazine starts well. There appears to be plenty of copy. The editor has no troubles with his text pages. Then the idea loses interest and time, effort and persuasion are needed to bring out the next issues. In a word, The house organ is attacked by some germ which lies in wait for the publisher of any new journal—the germ of lack of interest and lack of copy. Also, it may be said, though it is not meant unkindly, that an industry may suffer from too many house organs. Competing firms will extend their competitive efforts from their manufactures to house organs. Ultimately the stage will be reached when the customer's mail will contain nothing but house organs, and the post clerks will have very definite instructions as to what to do with them. Waste paper baskets are expensive things in these days ! !

Association Journals.

The habit of grouping among manufacturers which is now fashionable has brought with it the tendency to publish Association journals. These are supported by members of the Association, and chiefly have a free circulation even though they bear some price mark. It is assumed that this form of publicity will carry weight and give the impression that a particular group of manufacturers is the right one with whom to do business. This is a form of publicity which costs the Association (especially in these days) large sums of money. While it is true that the journals in question are well produced, one important factor seems to be lost sight of. They are obviously glorified catalogues biased in that they represent only a portion of manufacturing opinion, and therefore lack the weight and authority which attaches to an independently published organ.

Further, they compete with the recognised trade journals which have been associated with the particular industry for many years, and have helped to build it up. Probably manufacturers do not look at it in this way. Actually, they are spending a lot of money and time in publishing matter and advertisements which could better be dealt with through the medium of the regular press. The writer suggests that this policy be given serious consideration, particularly at a time when there is a shortage of paper, and also the need for every individual and every firm in the industry sticking to their own last. It may be a bitter pill to swallow, but it would undoubtedly have a salutary effect.

American Advertising.

Engineering firms, in the writer's opinion, have nothing to learn from American advertising. With every respect to our trans-Atlantic neighbours, the native article—that is the real British advertisement—easily beats all comers. American advertisements lack that dignity which seems to pe exclusively and characteristically British. It is something which no straining after on the part of the American can reach. It must always be remembered that the Americans derived their first ideas on advertising (with much other knowledge) from this country—and the better kind of American will acknowledge that this is so. There is a flashiness about American advertising which makes people consider it worthy of imitation; on the other hand, there are many who would not have the American type of advertisement at any price. What any other country can do well the British can do better— if they will just take the trouble. One only needs to turn to the British record in the Great War to prove this, if proof be needed.

The Agent.

At present very little engineering trade press advertising is handled by agents. A word might, however, be said in season on the vexed question of agents' commissions. The agent is not popular with engineering journals, because in the majority of cases he is simply a "discount snatcher." For instance, he takes the business of a regular advertiser, sends the renewal orders to the journals and calmly deducts 10 per cent commision! More often than not the only "service" he renders the advertiser is to pay the account and keep the blocks! Some journals resist this kind of thing by refusing to pay any agency commission. Other papers accept these terms, but the matter should be settled one way or another. The evil of the present arrangement is that either the agent is paid twice, *i.e.*, by the client and the journal, or only by the latter. It is not unknown that the agent returns to the client all or part of the commission paid by the journal. Looked at from a business point of view, if the agent is a genuine one and gives service, that service should be paid for by the client and not by the journal. There is no intention to speak unkindly of agents, but, as a class, they have been encouraged to live chiefly on commissions from the papers. It is an instructive and significant fact that there are agents who will not accept commissions from the papers. They point out to their clients the trouble usually caused, and, rather than give rise to this, they boldly ask the client to bear the cost of their service. Were this plan generally adopted it would clear up a long standing dispute.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

OFFICIAL LECTURE: "THE DESIGN AND APPLICATION OF HIGH-SPEED GEARING." By M. CORONEL (Member).

This paper is a most worthy member of an admirable series. Gearing problems figure prominently from the early days of engineering. The necessity for radical economising in space limits, and the consequent introduction of high-speed motive power, has changed things almost out of recognition. In the evolution of gearing, revolution has played its part. The lecture under review gives the reader a clear and graphic exposition of the design and functioning of the agent which reduces the high speed of the prime mover to the comparatively laggard velocity of the propeller or other shafting.

There is much more in this paper than the title would suggest. High-speed work bulks largely, and is the principal feature, but a great amount of valuable information on slow-speed gearing is included also.

To give an idea of the scope of the treatment, there are notes on the three methods of manufacturing; then worm and bevel gears are discussed. The lecture proper deals with spur gearing for general, and in particular for turbine work. Thus, the former treats of light work, as electrical driving, shop drives, etc., heavy loading for collieries, direct-driven rolling mills, haulage plant, and the like, and also of vertical double reducing gears. The latter is concerned with land and marine turbine reducing gears respectively.

In the tabulated data the general reader will find a fund of wealth, and the initiate much to enrich him. I think that the references in the text to Figs. 19 and 20 should be reversed.

Mr. Coronel, with the assistance of Mr. J. T. Steele, has succeeded in presenting a paper which all engineers should read.

[We have arranged to publish this paper, and the first instalment appears in this issue.—ED., *I. E*].

OFFICIAL LECTURE: "STEAM RAISING FROM WASTE MATERIAL." By DOUGLAS WILSON, A.M.I.M.E. (Member).

In these days, when economy is the paramount duty, such a lecture is particularly opportune. Where last century we should have been content merely to burn refuse, nowadays we have learned to yoke the energy released into harness. We have yet to discover how altogether admirably the team may work.

Mr. Wilson explains the how and the why of some of these things. He describes the processes involved and the plant necessary for steam raising from waste material. Text-book information is as yet very meagre; hence the paper under review meets a real need.

The author treats of the nature and composition of refuse, describes methods of disposal, and discusses the principles which underlie the design of the destructor plant itself. He is all out for constructive uses. The plant must not only secure the necessary destruction of the rubbish; it must provide means to direct the energy released into effective steam-raising channels for industrial and other purposes. He cites the case of Preston, which runs her tramcar system and lights her streets by power so generated.

There is discussion on types of furnaces, consideration of hand and of mechanical feed and clinkering. Fuller description of plant follows; then reference is made to the calorific value of refuse, rates of burning, and size of plant. Drughtsmen employed on such schemes have to thank Mr. Wilson for pertinent and valuable hints by the way.

The text, excellent in itself, is further enhanced by reason of the helpful illustrations. Some readers will possibly wish to join issue with the author anent the matter of hand versus mechanical feed and clinkering. The reviewer's advice to all interested is "Read this paper." W. ROLAND NEEDHAM.

*Price (to members), 1s. each; to non-members, 2s. each.

DIESEL ENGINE USERS' ASSOCIATION.

MARCH MEETING.

The subject of "Insurance of Diesel Engines Against Breakdown" was considered at the March meeting of the Diesel Engine Users' Association. Some years back the Association adopted a standard form of insurance policy at Lloyd's, and, as a result of experience gained in the working of this scheme of insurance, with periodic inspection by independent Diesel engine experts, it was considered advisable to amend the conditions of the policy in certain respects. The new form of policy, as recommended

by the Committee, after careful consideration, and as now adopted by the Association, elimates from its scope claims for cracks or partial fractures which do not in themselves result in an actual "breakdown," as defined in the definition. It was considered that not only would this alteration have the effect of eliminating in future certain difficulties and causes for dispute, but that it would be an advantage from the point of view of securing the best Diesel engine practice to make such costs chargeable to the ordinary annual maintenance account. It was pointed out that the main advantages which the user should have in mind in insuring his Diesel engine against breakdown were, in the first place, to secure himself against heavy financial loss in the event of an actual breakdown with or without resulting damage to surrounding property; and, secondly, to secure the advantages of periodic inspection by independent experts, and their advice and assistance in adopting the best practice, carrying out timely repairs, and in doing everything possible in their mutual interests to avoid the calamity of a serious breakdown. The Committee, in their report, pointed out that the amendments to the policy would be particularly beneficial to those users whose business was most valued by the underwriters, and that the alterations should eventually result in a reduction in the premiums charged; although, on the other hand, it would have to be borne in mind that the cost of all replacement parts, and of all repair and inspection work, including travelling costs, etc., was now very much higher than when this class of insurance was first considered by the Association, and that underwriters had already given some warning that it might be necessary to charge rather higher rates to cover such increased costs.

A paper on the subject of "Obturators" was read by Mr. W. Fennell. In pointing to the advantages claimed for the use of obturators in place of piston rings in petrol engines for aeroplane work, the author referred to the actual power wasted in piston-ring friction in many cases as being as much as 75 per cent of the total mechanical loss in an engine. The obturator was described as a sort of "cup leather" made of thin metal. These were originally made of brass, but were now made of specially selected phosphor bronze. They were usually placed very near the top of the piston, yet they did not burn, and this was explained by their flexible nature, which allowed them to keep in perfect contact with the cylinder and consequently well cooled. The author had experimented with obturators in Diesel engines to a limited extent, and their life had been about 300 hours. Further tests were in progress, and he thought that a life of well over 1,000 hours could be expected with a new liner. With the successful use of obturators, instead of piston-rings, the author considered that Diesel engine design might be considerably modified, resulting in reduced height and weight, and that this would facilitate the introduction of cross-head engines, as the question of thrust surfaces did not then come in.

Particulars concerning the Association can be obtained on application to the Honorary Secretary, Mr. Percy Still, M.I.E.E., 19, Cadogan Gardens, London, S.W.3.

The British Rawhide Belting Co. Ltd.'s new price list relates to "Chicago Rawhide" belting, oak-tanned leather, as well as balata belting. Special leaflets describe their well-known rawhide pinions, in which they carry on a large merchant's as well as a direct users' trade. Other specialities are their rawhide packing, mallets, and hide-faced hammers.

The Hamworthy Engineering Co. Ltd., 76, Victoria Street, London, S.W.1, have forwarded to us a copy of their new catalogue of oil engines. Illustrations and descriptions of various special uses are given, besides a detailed description of the engine. One particular quality that is emphasised is in regard to economy. The fuel and lubricating oil consumptions are exceedingly low, and the cost of working the engines isonly about one-third that of petrol engines of similar power. The Hamworthy 5 B.H.P. oil engine uses only three pints of paraffin per hour when working at full load. The economy of the other sizes is in the same proportion.

The Institution of Automobile Engineers.—The last ordinary general meeting of the Session of the Institution of Automobile Engineers will be held on Friday, May 14th, at the Technical Institute, Coventry, at 7-30 p.m., when a paper on "Cast Iron in relation to the Automobile Industry" will be read by Mr. J. E. Hurst. Cards of invitation to the meeting may be obtained on application to the Secretary, The Institution of Automobile Engineers, 28, Victoria Street, London, S.W.1.

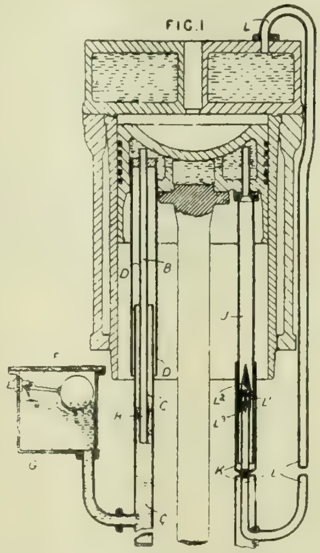
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

PISTONS.

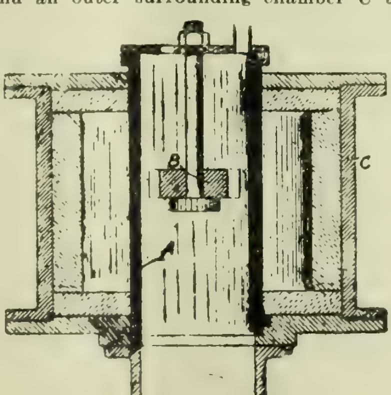
127,189.—North British Diesel Engine Works Ltd., South Street, Whiteinch, and J. C. M. Maclagan, 14, Park Corner, Westland Drive, both in Glasgow.—Nov. 15th, 1918.—The piston of a vertical internal-combustion engine is cooled by inducing a current of water through a water chamber therein. An inlet pipe B secured to the piston and communicating with the chamber dips into water in a stationary pipe C, which is maintained at a



definite level by means of a tank G provided with a ball valve F with which the pipe C communicates. A guard-pipe D surrounds the pipes B, C. The outlet pipe J dips into a stationary open pipe K and surrounds at the lower end a pipe L communicating with the water supply of the cooling-chamber of the cylinder head, and which is provided with an ejector comprising two conical elements L1, L2 and a guiding-cone L3. The action of the ejector starts the circulation, which is kept going by syphonic action. In a modification, suitable for a double-acting piston, the pipes D, B, J are connected to a cross head communicating with the piston.

FURNACES.

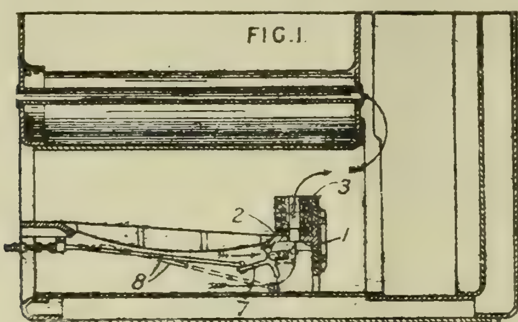
127,753.—J. S. Thompson, Nara, Halbrook Lane, Foleshill, Coventry.—July 2nd, 1918.—In apparatus for the heat-treatment of metals, of the type comprising an inner chamber A supplied with non-oxidising gas in which the article B to be treated is placed, and an outer surrounding chamber C to which heat

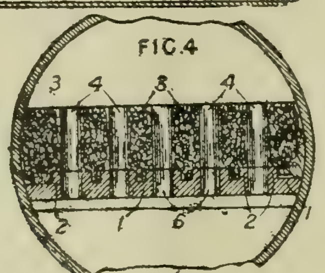


is supplied, the wall of the inner chamber is of nickel-chromium-iron alloy. A suitable composition is nickel 67.9 per cent, chromium 20.1 per cent, iron 10.53 per cent, silicon 1.27 per cent, and manganese 0.2 per cent. The chamber A may be heated by gas nozzles directed tangentially to the wall of the chamber by a resistance coil, or by solid fuel.

FURNACES.

128,105.—I. HALL, Kingsley Court, Edgbaston, Birmingham.—Oct. 21st, 1918.—In smoke-consuming furnaces, the bridge is made easily removable. It consists of a block 3 of heat-retaining material, preferably fireclay, supported on a bridge-plate 1, the plate and the block having vertical holes 6, 4 in alignment, and the block being retained in position by means of recesses

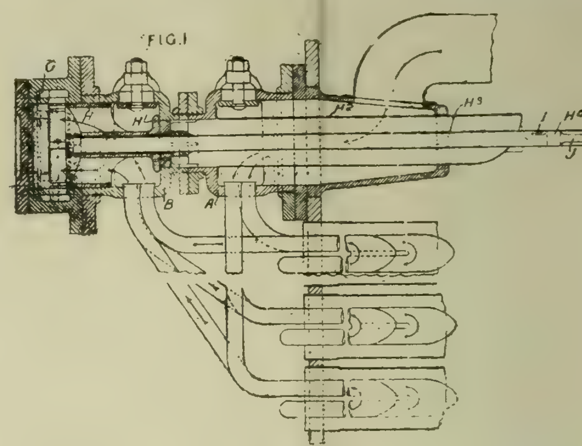




in the block engaging bosses 2 on the plate. A damper 7, actuated by a rod 8 extending to the front of the furnace, is provided either to allow air to pass through the holes 6, 4 to prevent smoke when firing, or to close them afterwards. If it is desired to produce a smoke screen, the damper is closed and the fire fed with damp fuel.

STEAM-SUPERHEATERS.

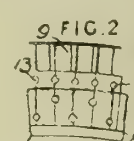
128,093.—BABCOCK AND WILCOX, J. KEMNAL, and J. HENRY, 30, Faringdon Street, London.—Sept. 28th, 1918.—In a superheater having a regulator valve of the piston type arranged on the outlet side of the superheater, as described in the parent Specification, the superheated-steam header forms the casing of the valve. The regulator valve H controls the passage of steam through outlet ports G in the end of the superheated-steam

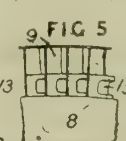


header B. A valve H1 formed integral with the regulator valve controls the return of steam through a pipe H2 extending through the saturated-steam header A and opening into the boiler-steam space. The port 1 in the hollow valve spindle H3 is controlled by a piston head H4 on the internal spindle J.

TURBINES.

128,404.—H. L. GUY, Trevethin, Albany Road, Victoria Park, Manchester, and BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., Norfolk Street, Strand, Westminster.—June





20th, 1918.—For equalising the pressure on the two sides of a steam-turbine disc, holes 13 are formed in or around the roots or packing-pieces of the blades 9 instead of in the disc 8.

INDEX TO ADVERTISERS.

[*When enquiring of Advertisers will readers kindly make a "special point" of mentioning* THE INDUSTRIAL ENGINEER.]

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VOL. VIII.] MAY 22ND, 1920. [No. 207.

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CONTENTS.

EDITORIAL.

MOTOR FUEL.

No one can fail to appreciate the menace of motor fuel shortage indicated recently by Sir Marcus Samuel, the head of the Shell Petroleum interest. There is no doubt that the cost of petrol will go still higher, and unless some method of curtailing consumption is found, there will be a very disastrous shortage at no distant date. It is certainly almost fatuous to talk of curtailment in consumption when one looks round and notes the tremendous productive energy of the motor industry. From America one hears of large extensions to existing plants, new manufacturing concerns, and speeding up production, which can only denote more cars and motor vehicles, and a consequent increased consumption of motor fuel.

One hears of new projects in regard to the extension and safeguarding our supply of motor fuel. At the meeting referred to above, Sir Marcus Samuel had something to say relative to the Government's recent adventures in regard to this question.

He pointed out that the Government was interested in only one oil producing concern—namely, the Anglo-Persian—and that such preferential treatment was likely to antagonise the other companies who were supplying this country with fuel.

There was a chance of the Government acquiring other interests—at any rate, it was open for it to do so.

Now we are at the research age, and every industry is providing money for particular research work. In regard to motor fuel, the oil companies have themselves contributed £250,000 for the purpose of endowing research in the field of motor fuels at Cambridge.

There is no doubt that the position is serious, not only to the actual user, but also to everyone in this country of ours. Motor transport to-day is absolutely essential, and we could not get along without it. It supplements the railways, and reduces the cost of many articles.

There is another matter on which useful research work could be done, namely, the increased production of industrial alcohol. When one considers that alcohol can be produced from almost every living plant, it will be agreed that there are vast supplies of raw material available throughout the world.

The fact must be agreed that we have cause to fear a shortage for vehicles that have become an absolute necessity. Coupled with the comparative restriction of supply, one views the enormous increase in vehicles with alarm—although a natural expansion. It has been very definitely stated that in the United States the expansion is so great that within the next few years no petrol will be exported from that country.

MAGNETIC CHUCKS.

By E. Austin.

In these days when every endeavour is being made to speed up production, the merits of magnetic chucks are well worthy of consideration. In certain cases the use of these chucks may considerably increase the daily output of machine tools, especially when the time needed for machining the work is short and the time occupied in fixing the work is the predominant factor. A magnetic chuck reduces the work involved in fixing iron and steel objects in machines to the simple operation of closing a switch, when the work is instantly gripped and securely held in position. Thin pieces of metal which are difficult to hold in machines by mechanical methods can readily be fixed with the aid of magnetic chucks. Though these chucks are used mainly on grinding machines, they are also applicable to other machines, such as planers, shapers, milling machines and lathes. A good example of the application of the magnetic holding-down principle to a grinding machine is shown in Fig. 1, where two chucks of the rectangular pattern are mounted on the reciprocating table. Five-hundred-and-twenty-eight cones are placed on the chucks as shown, and they are ground to a ·002 in. limit, and the time required to perform the work is about $1\frac{1}{2}$ hours, or about one-third of the time necessary when the work was done in accordance with a previous method.

Fig. 1.—Rectangular Magnetic Chucks holding small Cones on a Grinding Machine.

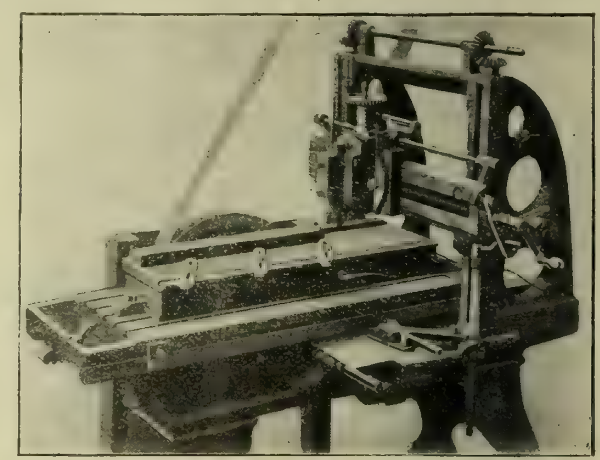


Fig. 2.—A Budgett Magnetic Chuck in use on a Planing Machine.

The application of a magnetic chuck to a planer is shown in Fig. 2. End and side stops are provided to enable the work to be readily placed in the correct position and to be firmly held by the magnetism. As the time required to remove the finished work and to place fresh work in position is only a fraction of a minute, the saving in time is very appreciable. On milling machines, rectangular types of chuck may be used with advantage for many kinds of operations. Fig. 3 shows a chuck of this description holding a bar of cold rolled steel 33 in. long, 2 in. wide and $\frac{3}{4}$ in. thick, and milled to a taper of $\frac{1}{8}$ in. per foot and to $\frac{1}{8}$ in. thickness at the left-hand end. Though the bar is naturally subjected to a considerable amount of

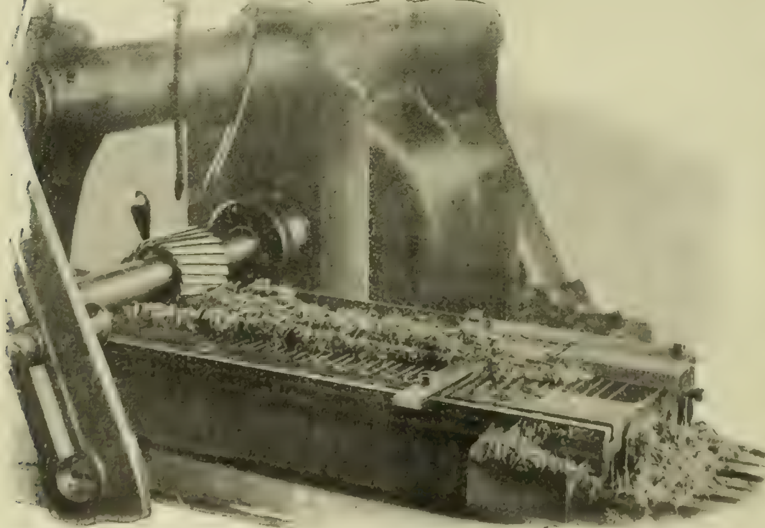


Fig. 3. A Magnetic Chuck in use on a Milling Machine.

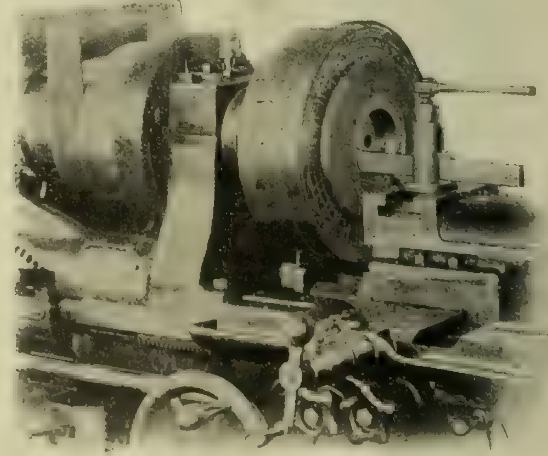


Fig. 5.—A Rotary Magnetic Chuck in use on a Lathe.

power, it has no tendency whatever to move. Another application of rectangular chuck to a milling machine is shown in Fig. 4, where thin plates are being miled to a thickness of ·125 in. and to a limit of ·0005 in.—·020 in. being removed from each side.

Rotary magnetic chucks as shown in Fig. 5 are useful for many kinds of chucking work, and are particularly advantageous when it is necessary to hold small and delicate objects such as piston rings, etc. The 12 in. chuck shown in Fig. 5, will stand a cut three-twenty-second in. deep with a ·027 in. feed, and by providing a retaining ring to counteract side thrust, the cut can be doubled without risk of the work shifting. The ring may be made of brass or other non-magnetic material. All the chucks, with the exception of the rectangular chuck shown on the planing machine in Fig. 2, are "Heald" chucks supplied by Alfred Herbert Ltd., of Coventry, and they can be used with or without water or other lubricants for cooling the work. The holding power of these chucks is said to vary from 100 to 200 lbs. per square inch, according to size. As will be seen from Fig. 6, these chucks have a large number of poles, and each pole has its own magnetising coil, and as the magnetic paths are short the maximum pull is secured. Soft steel of high permeability is used for the magnetic circuits. The magnetising coils are wound on formers taped and impregnated with insulating compound, and are then slipped over the poles. Obviously, by connecting the coils in different ways it is possible to make the chucks suitable for two different supply pressures, such as 110 or 220 volts. The outside casing of these chucks is never magnetised, all the magnetism being confined to the chuck surface and passing from pole to pole, the result being that there is no danger of magnetising machines to which these chucks are fitted. When the current is switched off the chucks lose all their magnetism, but certain classes of articles, such as hardened steel parts, are liable to retain a fair amount of magnetism, and in order to facilitate the removal of such objects from the chucks a reversing switch is provided, and with the aid of this switch the current in the magnetising coils is momentarily reversed, thus causing the chuck to release its hold. It does not necessarily follow, however, that the work will not retain magnetism which may interfere with the function of the finished parts. A magnetised milling cutter, for example, would obviously collect cuttings as soon as they were produced, and this would prove a source of nuisance to the operator. High-speed steel and cast steel parts are liable to become strongly magnetised on a magnetic chuck,

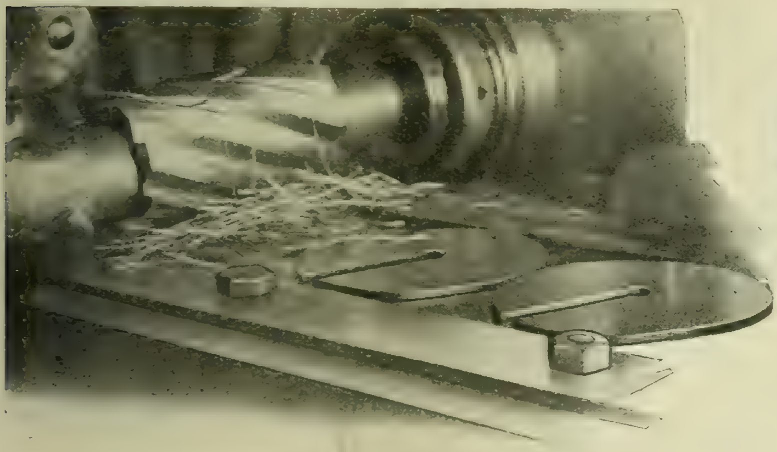


Fig. 4.—A Magnetic Chuck used holding thin plates in a Milling Machine.

Fig. 6.—The Interior of a Heald Machine.

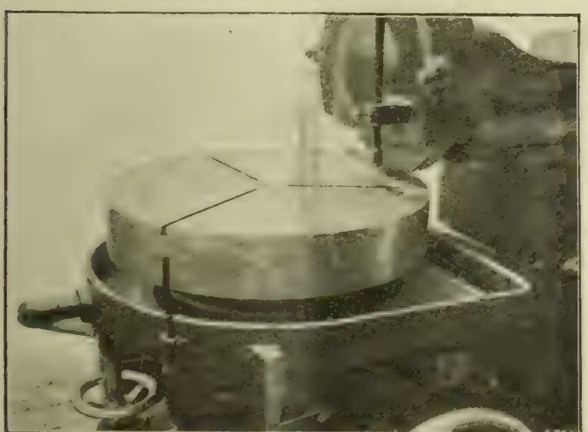


Fig 7.—A Humphrey Magnetic Chuck fitted to a Churchill Grinder.

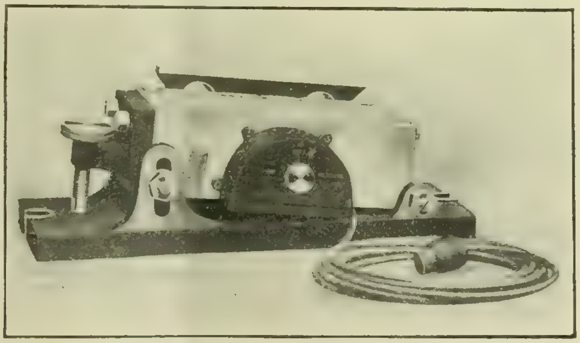


Fig. 8.—A Budgett Taper Chuck.

and manufacturers of these chucks therefore supply demagnetisers which readily remove any residual magnetism that may remain in the finished parts. Usually the demagnetising action is obtained by alternating current electro magnets mounted in a case. When only direct current is available a small rotary converted may be used for energising the demagnetiser, but the chucks themselves must, of course, always be energised with direct current. Magnetic chucks cannot be operated with alternating current, because the rapid reversal of polarity produced by such currents prevents the magnets giving continuity of holding power.

Another firm which supplies magnetic chucks is Messrs. J. H. Humphrey and Sons, of Horsedge Electrical Works, Oldham, and a Churchill rotary grinder fitted with one of this firm's chucks is shown in Fig. 7. Chucks made by this firm are also in successful operation on planers, shapers, and milling machines. These chucks are also made on the multiple pole principle, and are claimed to exert a very powerful holding force. The magnets are composed of soft steel of high magnetic permeability and are constructed so as to eliminate mechanical joints between the magnets and chuck face. The coils, like those of the chucks already described, are wound on formers, and before the winding work is commenced the wire is insulated with a special liquid having very high insulating properties and capable of withstanding weak acids, saline solutions, or alcohol. After the coils have been wound they are heated to a temperature of 250 deg. Fah., and placed in a heated tank from which all moisture is extracted by means of a vacuum. Finally, the tank is filled with an impregnating compound which renders the coils impervious to moisture. The chucks are claimed to be quite suitable for wet grinding. Humphrey chucks are made in the circular, rectangular and taper patterns, and special chucks are supplied for holding piston rings.

The rectangular chuck shown on the planing machine in Fig. 2 is a chuck made by H. M. Budgett, of Crown Works, Chelmsford. This firm also supplies various other types of chucks, rotary chucks, and special chucks for holding washers and piston rings. Another useful type of chuck made by this firm is the taper chuck shown in Fig. 8. It will be gathered that the chuck can be made to swivel on its base, and can be adjusted to take up any desired angle by means of the knuckle screw to be seen on the left. Like all the other chucks described, the Budgett chucks are waterproof and can be used for wet or dry grinding.

THE SWEDISH METALLURGICAL INDUSTRY.—Of the 132 blast furnaces in this country, 50 were in full operation at the end of October last, as compared with 52 in the month of June, 1919. As regards the Bessemer and Martin furnaces, from 50 to 55 per cent only were working, as against 58 in June. As might be expected, the production has consequently declined; in the third quarter of 1919, the production of cast-iron was only 99,000 tons, as against 171,200 tons for the corresponding period of 1918. In the whole of the metallurgical industry the production has been 305,600 tons, as against 416,700 tons in the same periods, and the exports were only 57,300 tons, as against 416,000 tons, or a decrease of 40 per cent. Imports have remained fairly steady, but those of rails have more than doubled, rising from 7,300 tons to 16,000 tons. Workmen in this industry have been agitating for, and have secured, higher wages; they are now insisting upon the introduction of an eight hours day. Probably they will prove successful in this direction also.

RECENT ADVANCES IN UTILISATION OF WATER-POWER.

By. ERIC M. BERGSTROM, of London,
Associate Member of the Institution of Mechanical Engineers.

Introduction.

Water-power engineering and development of water-power have, in common with most branches of engineering, made very rapid progress during the last 15 to 20 years, but the fact that comparatively few opportunities exist in the British Islands for extensive development of water-power, accounts for the relatively small interest devoted to this subject by engineers at home.

The water-power resources of this country, however, are well worth closer attention, and the large amount of water-power existent in Canada, India, New Zealand, Tasmania, and within the Empire as a whole, awaiting development for both domestic and industrial purposes, imposes the necessity of more interest being devoted to this particular branch of engineering than hitherto; the more so since the lesson derived from the war makes it incumbent on ourselves to manufacture within the gates of the Empire, at any rate, the staple articles necessary for our leading industries, many of which depend to a very great extent on cheap power for their production, in order to compete successfully with material produced abroad. This applies notably to the manufacture of calcium carbide, nitrogen, aluminium, woodpulp, and a large number of chemical products, for all of which, with the exception perhaps of aluminium, we have been obliged to rely on foreign resources. Consequently, in view of the important rôle that water-power engineering will play in the coming struggle for industrial supremacy, it is desirable that the general knowledge of this highly specialised branch of engineering should extend over a very much wider circle than hitherto has been the case, and for that purpose the author proposes to give a synopsis of the most recent achievements, at the same time embodying the developments of water-power engineering from the beginning of the present century, which epoch constitutes one of the most important "milestones" in this development.

It is interesting to note that the progress in the development of hydraulic prime-movers during the last century was comparatively slow, the most common type of turbines employed being the well-known types of "Jonval," "Girard," and various forms of tangential or spoon wheels. With the advent, however, of the application of electricity on a commercial basis and the perfection in system of transmission and distribution, the development of water-power received a tremendous impulse, which marked the beginning of a new era resulting in very rapid progress and enabling the vast water-power resources of the world to be utilised to a degree which now forms such an important factor in our industrial life.

The extended field thus given to water-power development created a demand for a high-speed turbine also under comparatively low heads, and in order to meet this new condition American engineers turned their attention to the Francis turbine, invented in 1849,* and produced a high-speed type of runner

* J. B. Francis Lowell, Hydraulic Experiments, Boston, 1855.

known as the "American Type." The Francis turbine, however, was not unknown in Europe, but it was only at the beginning of 1900 that it was generally adopted, and, owing to its great advantages over any other existing type of turbine, it has taken the lead and revolutionised the whole aspect of water-power engineering. Although it was due to the enterprise and ingenuity of American engineers that this type of turbine was developed along experimental lines, so as to make it adaptable to the new conditions brought about by the introduction of electricity, it stands to the credit of European engineers to have laid the theoretical foundations which permitted its development to be accomplished along scientific lines and which has now brought this type of turbine to its present state of perfection.

TABLE I.

Period.	Jonval No.	Girard No.	Francis No.	Tangential wheels No	Total B.H.P.	B.H.P. per Turbine.
1850-1894.	904	883	7	623	179.256	74·2
1895-1899.	72	99	98	232	114,818	229·1
1900-1904.	8	16	464	300	390,252	495·1
1905–1909.	-	-	457	336	886,582	1118·0
1910–1914.	-	—	375	219	1,162,380	1956·8

As an illustration of the rapid extension of the use of the Francis turbine, it is interesting to note the manufacturing records, Table I, of an eminent European firm of turbine-makers, from which it is clearly shown that the Francis turbine has now superseded all other known types of low-pressure turbines. It is of particular significance to observe the increase in output per turbine, which indicates the modern tendency of installing less units but of larger capacity than hitherto employed.

This last-mentioned feature of modern hydro-electric development is also evident from a perusal of

TABLE II

No.	Plant.	Country.	Year of Installation.	Working Head in feet.	Output in B.H.P. per unit.	Number of Units.	Speed in R.P.M.	Output under head = 1 ft.	Output per runner under head = 1 ft.	Type.
1	Cataract Construction Co., Niagara.	U.S.A.	1895	136	5,000	10	250	3·15	1·575	Double enclosed vertical.
2	A. B. Glommens Traesliberi, Christiania.	Norway	1901	64·5	3,000	4	150	5·8	5·8	Single enclosed vertical.
3	Shawinigan Water and Power Co., Montreal.	Canada	1902	134	6,000	1	180	3·87	1·94	Double enclosed horizontal.
4	Canadian Niagara Co.	Canada	1903	133	10,250	3	250	6·68	3·34	Double enclosed vertical.
5	Svalgfors Power Station, Notodden.	Norway	1904	150	11,750	3	250	6·40	3·20	Double enclosed horizontal.
6	Ontario Power Co., Niagara.	Canada	1904	175	12,000	..	187·5	5·18	2·59	Double spiral horizontal.
7	McCall Ferry Hydro-Electric Power Station.	U.S.A.	1905	53	13,500	10	94	35·00	17·5	Double open vertical.
8	Great Western Power Co. .	U.S.A.	1907	525	18,000	4	400	1·5	1·5	Single spiral vertical.
9	Trollhattan Hydro-Electric Station.	Sweden	1909	106	12,500	8	187·5	11·5	5·75	Double enclosed horizontal.
10	Tokio Electric Light and Power Co.	Japan	1910	396	12,500	6	..	1·6	0·8	Double spiral horizontal.
11	Keokuk Hydro Electric Power Station Mississippi.	U.S.A.	1912	39	14,000	15	57·7	57·5	57·5	Single open vertical.
12	Aeltkarleby Hydro-Electric Power Station.	Sweden	1914	54	14,000	5	150	35·4	8·85	Quadruple open horizontal.
13	Cedar Rapids Power Station, Montreal.	Canada	1914	30	10,800	12	55·6	66·0	66·0	Single open vertical.
14	Alabama Power Co........	U.S.A.	1914	68	17,500	6	100	31·0	31·0	Single open vertical.
15	Laurentide Power Station .	Canada	1915	76	20,000	6	120	30·0	30·0	Single open vertical.
16	The Tallassee Power Co. ..	U.S.A.	1916	180	31,000	..	154	12·85	12·85	Single enclosed vertical.

Table II., in which the most representative installations built since 1895 have been tabulated; but perhaps an even more striking illustration is furnished by figures recently published by an American manufacturer, who commenced the manufacture of the Francis turbine in 1895, and since that date has completed installations with an aggregate output of 1,683,720 B.H.P. corresponding to an average output of 8,000 B.H.P. per turbine delivered.

The turbines for the Cataract Construction Company, Niagara, built in Europe in 1895, which at that time were the largest units ever installed, in respect of output, have now been placed in the background in comparison with units installed in modern power-plants both in America and Europe. It should be observed, however, that the comparative size of turbines can only be indicated by their output under an equal head, and for the purpose of comparison, the various outputs under the unit head of 1 ft., have been tabulated, which shows that the largest turbines in the world in respect of dimensions are those erected at the Cedar Rapids in Canada, which installation will be reverted to later. By way of comparison, Table III. shows the most representative high-presure turbine installations installed during the last 15 years.

According to broad principles, the turbines are classified in two categories, namely, reaction and impulse turbines.

The Francis turbine belongs to the former, and the high-pressure impulse turbine—or more familiarly known as "Pelton Wheel"—belongs to the latter category, and being the only types of turbines now employed in modern water-power development, it is unnecessary to deal with any other type, except as far as historical interest is concerned.

TABLE III.

No.	Plant.	Country.	Year of Installation.	Nett Head in feet.	Output per Unit in B.H.P.	Number of Units.	Speed in R.P.M	Type.
1	The Mexican Light and Power Co., Necaxa.	Mexico	1903	1,279	8,200	6	300	4-jet vertical.
2	Brusio Hydro-Electric Plant	Switzerland	1905	1,350	3,500	12	375	Single-jet horizontal
3	Rio de Janeiro Tramway, Light and Power Co.	Brazil	1906	950	9,000	6	300	4-jet vertical.
4	British Aluminium Co. Ltd., Kinlochleven.	Great Britain	1907	900	3,300	11	300	Double-jet horizontal.
5	Tysse Hydro-Electric Plant	Norway	1907	1,260	4,800	7	375	Single-jet horizontal.
6	Rjukanfos Hydro-Electric Plant, Station I.	Norway	1908	930	14,450	10	250	4-jet twin runner horizontal.
7	Loentch Hydro-Electric Plant	Switzerland	1908	1,075	6,000	4	375	Double-jet overhanging horizontal.
8	The Mexican Light and Power Co., Extension.	Mexico	1909	1,279	16,000	2	300	4-jets vertical.
9	Biashina Hydro-Electric Plant	Switzerland	1909	850	11,000	3	300	4-jets vertical.
10	South California Edison Co., Kern River, Plant I.	U.S.A.	1910	865	10,750	4	250	2-jet twin runner overhanging horiz.
11	Lake Bunzen Hydro-Electric Plant, Station II.	Canada	1912	395	13,500	3	200	8-jets quadruple runner horizontal.
12	Kinugawa Hydro-Electric Plant....	Japan	1912	1,050	6,000	6	375	Single-jet horizontal.
13	Rio de Janeiro Tramway, Light and Power Co. Extension.	Brazil	1912	950	20,000	2	300	4-jets vertical.
14	Loentch Hydro-Electric Plant Extension.	Switzerland	1913	1,150	16,000	1	300	Double-jet overhanging horizontal.
15	Tata Hydro-Electric Plant, Bombay	India	1914	1,650	13,500	6	300	Single-jet horizontal.
16	Rjukanfos Hydro-Electric Plant, Station II.	Norway	1914	830	16,400	10	250	4-jet twin runner horizontal.
17	Aura Hydro-Electric Plant	Norway	1916	2,350	23,500	6	250	Single-jet horizontal.

Francis Turbines.

The Francis turbine, named after its American inventor, has a runner of the radial inflow type, the water entering the runner with a velocity corresponding to only a portion of the head, approximately half, and the remaining pressure-energy is utilised to accelerate the water during its passage through the runner. It is characterised by the varying conditions of head and speed for which it can be adapted, in which is to be found the reason for its popularity,

which has been fully justified by recent developments in its design.

As is well known, the main characteristics of a turbine are :—

(1) Head in feet (Symbol H).
(2) Output in B.H.P. (Symbol P).
(3) Quantity of water in cubic feet per minute. (Symbol Q).
(4) Speed in revolutions per minute (Symbol N).

If we assume that under the given head of H feet the characteristics of the turbine are P, Q, and N respectively, the corresponding characteristics for the unit head of one foot would be

$$\frac{P}{H\sqrt{H}}, \quad \frac{Q}{\sqrt{H}}, \quad \frac{N}{\sqrt{H}},$$

which are termed the unit speed, unit quantity of water, and unit output for any turbine.

This turbine under the head of H_x feet would consequently have the following characteristics :—

$$P_x = \frac{P H_x \sqrt{H_x}}{H\sqrt{H}}, \quad Q_x = \frac{Q\sqrt{H_x}}{\sqrt{H}}, \quad N_x = \frac{N\sqrt{H_x}}{\sqrt{H}}.$$

The above conditions apply only to turbines of the same diameter and design, and in order to compare turbines of different diameters and operating under entirely different conditions, the factor known as the "specific speed" has recently been introduced (Symbol N_s), which term indicates the speed any given turbine would run at when operating under the unit head of 1 ft. and having an output of 1 B.H.P.*

To arrive at the value of the specific speed N_s, which now has been universally adopted in modern classification and design of runners, let it be assumed as in the previous instance, that a turbine runner has been designed to develop P brake horse power with a speed of N revolutions per minute under a head of H feet, the corresponding quantity of water being Q cubic feet per second. If we let the head remain constant and conceive all the dimensions to be varied in exact proportion to the diameter D, we can obtain any number of geometrically identical runners with a varying diameter D_x. All the areas of the runners would vary in direct proportion to the square of its diameter, and consequently the quantity of water and output would vary in the same proportion, and we can write :—

$$\frac{Q}{Q_x} = \frac{P}{P_x} = \frac{D^2}{D^2_x}$$

where the index X denotes the values of P and Q corresponding to the diameter D_x.

On the other hand, the speed would vary inversely with the diameter, and hence

$$\frac{N_x}{N} = \frac{D}{D_x} \text{ or } N_x = N \times \frac{D}{D_x}$$

For P_x = 1 B.H.P. we write

$$P = \frac{D^2}{D_1^2} \text{ or } \frac{D}{D_1} = \sqrt{P}$$

and the corresponding speed

$$N_1 = N \times \frac{D}{D_1} = N\sqrt{P}.$$

If in this formulæ we substitute the values N and P being the speed and output under the head of H feet with the corresponding unit values, we arrive at the expression for the specific speed, thus :—

$$N_s = \frac{N}{\sqrt{H}} \times \sqrt{\frac{P}{H\sqrt{H}}} = \frac{N \times \sqrt{P}}{\sqrt[4]{H^5}}.$$

The value of the specific speed applies only to one runner, and in case of a turbine with two or more runners P in the furmulæ represents the output per runner, or if P represents the total output the value of N_s must be divided with the square root of the total number of runners.

The relation between N_s in the metric and foot-lb. system can be expressed through the following formulæ :—

$$N_s \text{ (metric)} = 4{\cdot}447\ N_s \text{ (foot-lbs.)},$$

and throughout this paper the metric equivalent is quoted in brackets.

It is easily recognised that the value of the specific speed owing to the limitation of design consistent with good efficiency has a minimum and a maximum value, the minimum being approximately 11 (50), and the maximum, only a few years ago, approximately 75 (330), although recent improvements in design of runners have advanced this latter value to approximately 100 (450).*

Fig. 1 shows diagrammatically the various forms of runners with corresponding values of the specific speed, A being a runner of the slow-speed type using a small quantity of water under a high head, whereas E shows the latest design of high-speed runner using a large quantity of water under a low head.

It has already been mentioned that the high-speed Francis turbine runner was evolved in America by way of experiment, and was made a prototype for

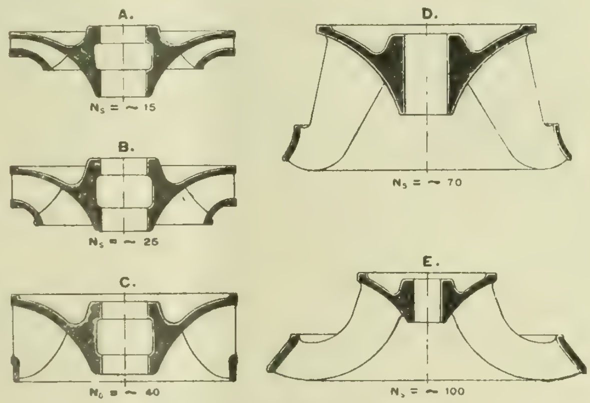


Fig. 1.—Runners for Francis Turbines.

standard turbines, which were sold under various trade names once so familiar to all engineers. The standard turbine was admirably suited to small water-power installations, and on account of standardised manufacture, was sold at an exceedingly low cost, but the fact that the method of standardisation was not founded on a strictly theoretical basis militated for a long time against improvements in design and manufacture of turbines suitable for conditions of large hydro-electric developments.

In Europe, on the other hand, as soon as the favourable features of the Francis type of turbine had been

* Dr. Camerer : "Grundriss der Turbinentheorie," 1903.

* S. J. Zowski. "Some Recent Tests of High-power, High-speed Turbines." *Engineering Record*, December, 1914.

recognised, its design was developed along scientific lines with a view to utilising, under the most favourable conditions, the great natural water-power resources existent to meet the growing demand for cheap power in bulk.

The individuality in design and precision in workmanship created by this method, in addition to the established practice of designing each turbine to suit the existing conditions in each particular installation, paved the way for utilising water-power on a very much larger scale than that at first anticipated. It is significant to note that the first large hydro-electric plant installed at Niagara in 1895 was built in Switzerland, and was followed by several larger plants which fact, perhaps, brought home to American manufacturers the superiority of the European practice and caused leading manufacturers in the United States to adopt this method.

The many advantages which were undoubtedly offered by the standardisation of turbines were, however, fully recognised in Europe, and in the value of "specific speed" was found the basis for a method of standardisation which permitted the manufacture under more advantageous commercial conditions, having due regard at the same time to efficiency and high standard of workmanship.

From the foregoing remarks it will no doubt be appreciated what an important link this exchange of ideas between the two continents has been in the development of this type of prime mover, enabling a very much more rapid progress than would otherwise have been the case.

Most of the leading manufacturers have now adopted the manufacture of standard runners, each series corresponding to a certain specific speed and selected to meet the conditions most frequently met with. It will be realised that owing to he multitude of varying conditions which have to be considered, this system may not always cover the complete field, and special designs have to be resorted to, but usually the modern standard runner covers such a wide range that in most cases where no abnormal conditions are imposed, they can be used with great advantage.

One very important factor in connection with the modern standard turbine is the exhaustive tests to which each series have been subjected, and consequently a full knowledge of its efficiency and other characteristics is available, making it possible to predict with the greatest accuracy its behaviour under a variety of conditions and enable a selection of a runner which will most efficiently meet a given set of requirements.

It is on these improved methods of systematic tests and correct designs that the standardisation of the modern turbine has been based and developed, and is by no means synonymous with the earlier attempt of standardisation, where the manufacturer lacked the knowledge of the chief characteristics of the turbine, with the result that the turbines were very often installed under conditions for which they were not suitable, indeed, whereas the modern system has encouraged further developments, the early American practice, due to its empirical nature, tended to bar progress and render abortive every effort of development along rational lines.

BOILER EXPLOSIONS AND FEED-WATER DEFECTS.

A MICROSCOPICAL EXPLANATION

Written and Illustrated by James Scott.

A great deal has been written upon the subject now about to be dealt with, and it is inevitable that I shall repeat some information with which the reader is already acquainted. But I hope to enlighten him in respect of the actual sources of mischief with the help of microscopical investigation.

Hardness in water has been somewhat arbitrarily divided into *temporary* and *permanent;* the first being that which is removed by boiling, and the second that which is not influenced in this manner but remains behind. In other words, the minerals responsible for temporary hardness are separated by heat in the form of loose, minute crystals and grains, which float in the water. If the latter is then filtered it contains only the minerals responsible for *permanent* hardness, to which the formation of scale is principally, but not wholly, due. Both these varieties of minerals must have an influence in producing scale, because the floating particles can adhere to metal as the level of the water is lowered and they are gyrated thereon; while the dissolved salts can be freed during evaporation and concentration of the water, and be blended with the others.

The chief substances which cause scale are compounds of lime and magnesia, known as alkaline earths. The *temporary* ones include carbonates of these elements, held in solution by an excess quantity of the gas carbon-dioxide, which really converts them into bi-carbonates. Chalk is typically lime carbonate, but a certain proportion of carbon-dioxide dissolves this into soluble lime bi-carbonate. Upon boiling this solution the excess carbon-dioxide is eliminated, and insoluble lime carbonate (chalk) is left as a white deposit.

Magnesia forms double carbonates with excess carbon-dioxide, but during constant boiling all the gas is driven out, and the substance is precipitated as insoluble magnesia hydrate.

This same compound—magnesia hydrate—can be obtained if, instead of boiling the water, a carefully calculated percentage of slaked lime is added to it. Two equivalents of slaked lime precipitate one equivalent of magnesia.

Similarly, if slaked lime is added to a solution of bicarbonate of lime a lot of carbon-dioxide is displaced, or liberated, as visible lime carbonate is settled out.

Upon these facts are founded some well-known processes for rendering feed water suitable for boilers, the lime and magnesia being removed before the water is heated.

Caustic soda and caustic potash give results very much like those just mentioned. In the first case soluble soda carbonate forms, and this reacts with some of the minerals of permanent hardness, and throws them down as tangible lime and magnesia carbonates

Potash gives effects of a like kind, potash carbonate first appearing.

The reason why tannates—which are compounds of tannin (*i.e.*, tannic acid) with something else, such as soda—are widely favoured as boiler compositions is because tannin displaces the carbon-dioxide

of bi-carbonates, and thereby brings about the separation of carbonate particles, which are easily removed. The tannin can still further operate advantgeously on the carbon-dioxide of the carbonates, considerably reducing the trouble traceable to them.

It is the lime and magnesia particles which get blown out of boilers when the customary practice of sludging is performed. If this precaution is neglected, some of the temporary salts combine with the permanent ones to form scale.

Some engineers successfully use both slaked lime and soda carbonate together at this same time

Sulphates of lime and magnesia and chlorides and nitrates of various kinds occasion permanent hardness. These cannot be precipitated by slaked lime, or bolling; nor do they combine with tannin compounds. These salts are fixed on the plates as permanently hard, injurious crystalline scale, which eventually becomes porous.

The action of soda carbonate (washing soda is thus indicated) produces a double decomposition of lime sulphate, which is a conspicuous offender in scale formation, and the outcome is the development of soda sulphate (this is soluble and remains in solution) and lime carbonate (this is precipitated as an easily washed-out powder.

"Permanent hardness is most objectionable for waters employed for boiler feeding, and calcium (lime) sulphate is especially so, as it becomes nearly insoluble in water at 15 deg. Cen., or 55 lbs. steam pressure, and is deposited on the plates as a hard crystalline scale which has to be chipped off with a hammer," so says a prominent boiler authority.

Scale of $\frac{1}{16}$th (one-sixteenth) inch thickness reduces the efficiency of a steam boiler so much that 10 per cent heat losses are involved. The importance of the matter is, therefore, very obvious.

"Scale cannot be annihilated by the use of chemical reagents; all that the latter can do is to render the scale soft and easily removable." Thus has stated a leading expert in boiler management.

When hard water is boiled a lot of the mineral matter is separated as minute crystalline tufts and flakes, which are cast about freely until the water is allowed to cool, when they rise to the surface as white specks. Those which get impregnated with iron oxide, or rust may then sink to the bottom. This is loose scale, and interferes with the proper boiling of the water.

"A composition could be supplied which would, more or less rapidly, have the desired effect of causing the disappearance of existing scale, but as it is only acids which will dissolve existing scale, it follows that a composition claiming to do this must be unsuitable in a boiler, and no engineer, knowing the connection between the presence of acid and the dissolving of scale, would care to use such a preparation." This is the conclusion of an eminent scientist, and it proves that haphazard methods in relation to boiler treatment must be avoided.

It should be borne in mind that mineral salts concentrate during the boiling of water, so that their relative proportions gradually increase; and they must go somewhere, either settling as scale or blocking up pipes, and so on.

If oil or grease is present in a boiler, sludging will not properly remove it, and it remains adherent to the plates, at the same time keeping back a great deal of the loose mineral matter with which it forms a bulky emulsion.

"As the lime and magnesia of temporary hard water is thrown down by boiling, it is deposited in steam boilers as a soft precipitate, much of which can be blown out by suitable sludging; but if oils or fats obtain access to the boiler, a soft, bulky adherent deposit is formed, keeping the water from the plates, which may become red-hot and lead to collapse or explosion." This is the statement of an expert, and I am endeavouring to explain how these things occur.

It must be noted that only vegetable and animal oils are capable of giving these disastrous effects. Mineral oils, instead of being dangerous, are actually beneficial, as they tend to keep the plates clean. But unless they are absolutely pure they cannot be relied on. It is quite customary for manufacturers

Fig 1.—About one-thirtieth inch of a layer of mineral matter which becomes *fixed* to objects in which water is boiled; magnified. The crystals gradually fuse together, and become porous.

to mix vegetable and animal oils with mineral oils, so that the risk is often present unsuspected.

Although it has been fully established that grease and oil cause the explosion of boilers, it is difficult to describe the exact procedure of the different stages which occur from cause to effect.

The mild-steel plates of which so many boilers are composed improve in strength by an increase of temperature up to 550 deg. Fah., after which they graduall weaken. Above 600 deg. Fah. they get so badly overheated that they suffer severely, and may give way altogether.

It is sometimes very difficult to trace grease and oil, owing to the manner in which it splits up, as described later on. Amounts so small, that one would hardly suspect them to have any evil tendencies, are sufficient to bring about boiler explosion.

The manner in which grease and oil can enter a boiler does not need detailing here. Its principal source is the lubricants used on the working parts. But cleaners have been known to leave greasy cotton waste behind them in the cylinders.

It should be borne in mind that although water containing oil continues to evaporate, the oil itself does not do so; but, instead, gets concentrated.

By making direct observations and experiments, I find that, however small the drops of oil are, they split up still smaller as the boiling water throws them about, until they become so minute that it is often hard to distinguish them under even the highest powers of the microscope.

Multitudes of them are as tiny as one-hundred-thousandth-of-an-inch in diameter, and it is impossible to filter them off. To eradicate them some chemical method has to be resorted to which will combine with them to compose a gummy matter readily held back on filtering media.

These tiny globules mix with the floury mineral matter, and comprise a foamy emulsion, which prevents the steam bubbles from rising. As the heat canot pass satisfactorily from the plates to the water they get red-hot, fractured, and otherwise maltreated, with the disastrous consequences already stated. Micro-inspection is worth a few moments' thought.

By leaving glass slides in water which is boiled completely away, we are able to secure a mineral

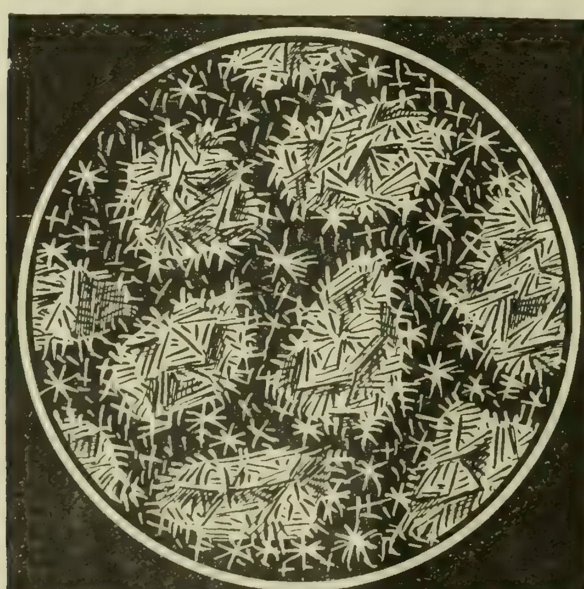


FIG. 2.—About one-thirtieth inch of a layer of *floating* mineral matter in boiling water; magnified. It consists of rafts composed of clusters of minute crystals.

deposit of the kind which forms scale. Such a result is shown in No. 1, but the details vary even in a few inches space of mineral matter from any one test. Typical formations are, however, selected. These crysals, in course of time, overlie one another, fuse together, crack, and otherwise behave to yield the hard, dense crust with which all engineers are familiar. Yellow and brown staining is due to iron oxide or rust.

If the *floating* particles of mineral matter seen in boiling water are caught on a glass slide they are found to consist of tiny rafts of aggregated crystals of the kind shown in No. 2. It is these which combine emulsion, but they break up to scraps.

In No. 3 is shown some of an emulsified deposit with the oil present in the water to form an obstinate film of oil and mineral matter; the first-named being almost invisible owing to transparency. But their contours glisten in certain circumstances.

"Many really good firemen have been discharged for supposed neglect, when as a matter of fact the

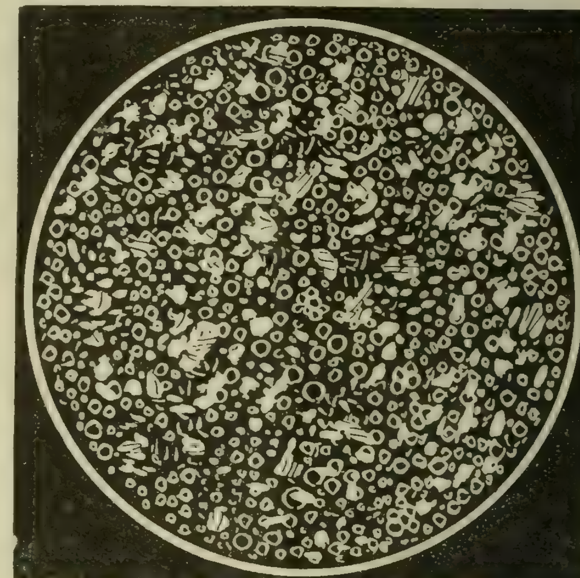


FIG. 3.—About one-thirtieth inch of a layer of oily mineral matter obtained from boiling water; magnified. The oil is in minute globules which form an emulsion with the floury minerals.

trouble has been entirely due to the presence of grease in the boilers." This is the conclusion of an experienced engineer, and is very significant. The remark proves that the subject handled in the preceding lines is one of the greatest possible importance.

FUNCTIONAL DIAGNOSIS.

THE strength of a chain is in its weakest link, in which, and for which, the well-known factor of ignorance was established; it is not so well known, however, that the weakest part of a well-made link is not the weld, as when subjected to destructive test the break very rarely occurs at this point. The callus formed by the weld seems to add strength to the material, and it is a fact which can be verified by experiment that a well-made chain breaks anywhere but at a weld.

Finding the weak place or the joint in the armour, so that fault may be remedied, is functional diagnosis. The term, common enough in medicine, is not yet established in engineering; it is, however, the chief end of management to eliminate the errors of omission and commission, which creep into the best regulated establishments; and while mere patching is an empirical remedy, real diagnosis by function will after due reflection and location of the weakness find a means to prevent is recurrence. There is all the difference between treating the symptom or curing the disease between the two methods of attack.

It is difficult to define the intangible art of management. It has been described as chasing the daily difficulty, not altogether a bad definition, but

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 78 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	6 3 24	0 13 3 20	1 0 3 16	1 7 3 12	1 14 3 8	2 1 3 4	2 8 3 0	2 15 2 24	3 2 2 20	0
1	0 2 22	7 2 18	0 14 2 14	1 1 2 10	1 8 2 6	1 15 2 2	2 2 1 26	2 9 1 22	2 16 1 18	3 3 1 14	1
2	1 1 16	8 1 12	0 15 1 8	1 2 1 4	1 9 1 0	1 16 0 24	2 3 0 20	2 10 0 16	2 17 0 12	3 4 0 8	2
3	2 0 10	9 0 6	0 16 0 2	1 2 3 26	1 9 3 22	1 16 3 18	2 3 3 14	2 10 3 10	2 17 3 6	3 4 3 2	3
4	2 3 4	9 3 0	0 16 2 24	1 3 2 20	1 10 2 16	1 17 2 12	2 4 2 8	2 11 2 4	2 18 2 0	3 5 1 24	4
5	3 1 26	10 1 22	0 17 1 18	1 4 1 14	1 11 1 10	1 18 1 6	2 5 1 2	2 12 0 26	2 19 0 22	3 6 0 18	5
6	4 0 20	11 0 16	0 18 0 12	1 5 0 8	1 12 0 4	1 19 0 0	2 5 3 24	2 12 3 20	2 19 3 16	3 6 3 12	6
7	4 3 14	11 3 10	0 18 3 6	1 5 3 2	1 12 2 26	1 19 2 22	2 6 2 18	2 13 2 14	3 0 2 10	3 7 2 6	7
8	5 2 8	12 2 24	0 19 2 0	1 6 1 24	1 13 1 20	2 0 1 16	2 7 1 12	2 14 1 8	3 1 1 4	3 8 1 0	8
9	6 1 2	13 0 26	1 0 0 22	1 7 0 18	1 14 0 14	2 1 0 10	2 8 0 6	2 15 0 2	3 1 3 26	3 8 3 22	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q lbs.	Weight.
	6·5	15	19·5	26	1 4·5	1 11	1 17·5	1 24	2 2·5	2 9	2 15·5	2 22	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 78 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs	t. c. q. lbs.	t. c. q lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	Ft.
0	..	3 9 2 16	6 19 1 4	10 8 3 20	13 18 2 8	17 8 0 24	20 17 3 12	24 7 2 0	27 17 0 16	31 6 3 4	0
10	0 6 3 24	3 16 2 12	7 6 1 0	10 15 3 16	14 5 2 4	17 15 0 20	21 4 3 8	24 14 1 24	28 4 0 12	31 13 3 0	10
20	0 13 3 20	4 3 2 8	7 13 0 24	11 2 3 12	14 12 2 0	18 2 0 16	21 11 3 4	25 1 1 20	28 11 0 8	32 0 2 24	20
30	1 0 3 16	4 10 2 4	8 0 0 20	11 9 3 8	14 19 1 24	18 9 0 12	21 18 3 0	25 8 1 16	28 18 0 4	32 7 2 20	30
40	1 7 3 12	4 17 2 0	8 7 0 16	11 16 3 4	15 6 1 20	18 16 0 8	22 5 2 24	25 15 1 12	29 5 0 0	32 14 2 16	40
50	1 14 3 8	5 4 1 24	8 14 0 12	12 3 3 0	15 13 1 16	19 3 0 4	22 12 2 20	26 2 1 8	29 11 3 24	33 1 2 12	50
60	2 1 3 4	5 11 1 20	9 1 0 8	12 10 2 24	16 0 1 12	19 10 0 0	22 19 2 16	26 9 1 4	29 18 3 20	33 8 2 8	60
70	2 8 3 0	5 18 1 16	9 8 0 4	12 17 2 20	16 7 1 8	19 16 3 24	23 6 2 12	26 16 1 0	30 5 3 16	33 15 2 4	70
80	2 15 2 24	6 5 1 12	9 15 0 0	13 4 2 16	16 14 1 4	20 3 3 20	23 13 2 8	27 3 0 24	30 12 3 12	34 2 2 0	80
90	3 2 2 20	6 12 1 8	10 1 3 24	13 11 2 12	17 1 1 0	20 10 3 16	24 0 2 4	27 10 0 20	30 19 3 8	34 9 1 24	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	34 16 1 20	69 12 3 12	104 9 1 4	139 5 2 24	174 2 0 16	208 18 2 8	243 15 0 0	278 11 1 20	313 7 3 12	348 4 1 4	

Compiled and Arranged by T. E. Woodhouse

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 79 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 0 6	0 14 0 12	1 1 0 18	1 8 0 24	1 15 1 2	2 2 1 8	2 9 1 14	2 16 1 20	3 3 1 26	0
1	0 2 23	7 3 1	0 14 3 7	1 1 3 13	1 8 3 19	1 15 3 25	2 3 0 3	2 10 0 9	2 17 0 15	3 4 0 21	1
2	1 1 18	8 1 24	0 15 2 2	1 2 2 8	1 9 2 14	1 16 2 20	2 3 2 26	2 10 3 4	2 17 3 10	3 4 3 16	2
3	2 0 13	9 0 19	0 16 0 25	1 3 1 3	1 10 1 9	1 17 1 15	2 4 1 21	2 11 1 27	2 18 2 3	3 5 2 11	3
4	2 3 8	9 3 14	0 16 3 20	1 3 3 26	1 11 0 4	1 18 0 10	2 5 0 16	2 12 0 22	2 19 1 0	3 6 1 6	4
5	3 2 3	10 2 9	0 17 2 15	1 4 2 21	1 11 2 27	1 18 3 5	2 5 3 11	2 12 3 17	2 19 3 23	3 7 0 1	5
6	4 0 26	11 1 4	0 18 1 10	1 5 1 16	1 12 1 22	1 19 2 0	2 6 2 6	2 13 2 12	3 0 2 18	3 7 2 24	6
7	4 3 21	11 3 27	0 19 0 5	1 6 0 11	1 13 0 17	2 0 0 23	2 7 1 1	2 14 1 7	3 1 1 13	3 8 1 19	7
8	5 2 16	12 2 22	0 19 3 0	1 6 3 6	1 13 3 12	2 0 3 18	2 7 3 24	2 15 0 2	3 2 0 8	3 9 0 14	8
9	6 1 11	13 1 17	1 0 1 23	1 7 2 1	1 14 2 7	2 1 2 13	2 8 2 19	2 15 2 25	3 2 3 3	3 9 3 9	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6.58	13·16	19·75	26·33	1 4·92	1 11·5	1 18·08	1 24·67	2 3·25	2 9 84	2 16·42	2 23	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 79 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 10 2 4	7 1 0 8	10 11 2 12	14 2 0 16	17 12 2 20	21 3 0 24	24 13 3 0	28 4 1 4	31 14 3 8	0
10	0 7 0 6	3 17 2 10	7 8 0 14	10 18 2 18	14 9 0 22	17 19 2 26	21 10 1 2	25 0 3 6	28 11 1 10	32 1 3 14	10
20	0 14 0 12	4 4 2 16	7 15 0 20	11 5 2 24	14 16 1 0	18 6 3 4	21 17 1 8	25 7 3 12	28 18 1 16	32 8 3 20	20
30	1 1 0 18	4 11 2 22	8 2 0 26	11 12 3 2	15 3 1 6	18 13 3 10	22 4 1 14	25 14 3 18	29 5 1 22	32 15 3 26	30
40	1 8 0 24	4 18 3 0	8 9 1 4	11 19 3 8	15 10 1 12	19 0 3 16	22 11 1 20	26 1 3 24	29 12 2 0	33 3 0 4	40
50	1 15 1 2	5 5 3 8	8 16 1 10	12 6 3 14	15 17 1 18	19 7 3 22	22 18 1 26	26 9 0 2	29 19 2 6	33 10 0 10	50
60	2 2 1 8	5 12 3 12	9 3 1 16	12 13 3 20	16 4 1 24	19 15 0 0	23 5 2 4	26 16 0 8	30 6 2 12	33 17 0 16	60
70	2 9 1 14	5 19 3 18	9 10 1 22	13 0 3 26	16 11 2 2	20 2 0 6	23 12 2 10	27 3 0 14	30 13 2 18	34 4 0 22	70
80	2 16 1 20	6 6 3 24	9 17 2 0	13 8 0 4	16 18 2 8	20 9 0 12	23 19 2 16	27 10 0 20	31 0 2 24	34 11 1 0	80
90	3 3 1 26	6 14 0 2	10 4 2 6	13 15 0 10	17 5 2 14	20 16 0 18	24 6 2 22	27 17 0 26	31 7 3 2	35 18 1 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	35 5 1 12	70 10 2 24	105 16 0 8	141 1 1 20	176 6 3 4	211 12 0 26	246 17 2 0	282 2 3 12	317 8 0 24	352 13 2 8	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

it is possible to be very active in this wise and yet merely skim the surface of the matter without reaching a solution. As with the chain, so elsewhere, to eliminate the weakest link in place of merely adding to the factor of ignorance is the truest wisdom. There are two methods in dealing with a weakness—one is to increase dimensions, the other is to increase the quality of the material; finding the actual cause in the first place, and by redesign altering the incidence of stress gives again another alternative. It is not altogether realised that mere numbers do not of themselves mean production or result; there is some validity in the contention that it pays to have superior material at an increase in cost rather than a mass of inferior stuff. A few able and resolute men have, before to-day, beaten in fair combat hordes of less skilful adversaries. Balance is nearly as important as quality, for inert material, however good, cannot take an active part in either mechanism or productivity. It will readily be granted that it is feasible to build a more costly article from inferior material badly arranged than from expensive material properly designed. Better a select and picked company few in numbers than an indiscriminate mob is another way of putting the same idea. After all, results justify themselves; they are the only proof that matters.

Efficiency and its consequent freedom from waste whether of effort or resource is the end wanted, and it matters little how expensive the prime outlay, it does matter a deal as to relative cost in terms of result. High capital cost of plant or high labour wages are in themselves no barrier so long as the plant gives output commensurate to its price, and the labour is worthy of its hire. The tendency to regard only a very small number as worth full reward, and to set these to direct an unintelligent mob who are the despair of the direction, places a premium upon extraordinary attainment; and since opportunity is confined to the few, the many will not qualify. A question often raised is again to the front: it is stated by those responsible that there is a dearth of men qualified for very large issues. There may be a dearth of men with experience of large issues, but that is another matter entirely. The opportunity of shouldering relatively large responsibilities at the right age for full development is restricted is true, but that there is a dearth of the right material is hereby denied. Nature has always been too prodigal of her gifts to confine the custody of the future to any favoured section of the community, who alone get the opportunity of making good in the larger sphere. Hence probably the lack evident.

Returning to more practical matters, no man having mechanical instinct ever rushes at trouble; he proceeds to examine the particular problem from as many points as are available, holds a post-mortem, schemes out all the possible variants, reaches at length the seat of the trouble, and having all the facts begins to devise a remedy: like the medical mechanic he treats the disease, not the symptom, and so cures the patient. Most of the troubles of this imperfect world are based on want of knowledge. As in medicine, applied commonsense—which after all is ingenuity in practice—leads to results; the cure for mechanical trouble is not something miraculous in a bottle, any more than No. 9 mixture off the shelf is a cure for all pain. The trouble, if deep-seated, may need more heroic remedies. Fortunately, in all connections, rational reflection usually provides a means of future prevention.

The weak link when found needs drastic treatment; though as we are all human we are all liable to err, the function of system and right organisation is to make mistake difficult and right practice easy; just as Government was once defined as making virtue easy and vice difficult. The incompetent will always, to the sorrow of the able, be in evidence; but his potentiality for mischief can be limited, as indeed by a sort of rough justice it usually is, yet it is often a cause for wonder how he escapes detection until the damage is almost beyond repair.

One aspect of the democratic idea is the large reservoir which in time of need can be tapped with advantage; one of the recent discoveries made in time of crisis was the amount of competence which abode in unlikely quarters—but why wait for crisis to discover latent talent—and why, when discovered, sacrifice new-found wealth?

SOME CONSIDERATIONS IN MODERN POWER TRANSMISSION SYSTEMS.

By Hartland Seymour.

An Important Problem.

Conveying and transmitting power in workshops is one of the many problems awaiting solution by works engineers in their campaign to reduce power costs in the factory. In many cases, the good results attained by eliminating losses in the power house are dissipated in the shops by the employment of inefficient power transmission systems. Not enough care has been exercised, in the first place, in the selection of shafting, bearings, hangers, belts and so forth.

Shafting.

Many mistakes are made when selecting shafting for the shops. It is essential, of course, that a shaft should be secured which is just slightly larger than actual requirements. That is to say, the horse power to be conveyed must first be ascertained, and then a shaft installed which will transmit that horse power in the most efficient manner. To ensure this, the most conservative power transmission tables should be consulted. Again, a great deal depends on the arrangement of the shafting.

Layout.

The layout of the transmission system is obviously dependent on the machinery to be driven. In some cases, of course, the machinery may be conformed to the shafting. It is always well to plan a transmission layout on paper before a final arrangement is come to. For this purpose, a scale drawing of the shop should be made, paper or cardboard models to scale of the machines cut, and these arranged and rearranged until the economical spacing has been attained.

All heavy machinery should, naturally, be grouped near the main drive so as to minimise the length of heavy shafting carried in the shop. Care should be taken not to utilise a shaft which is too small, or distortion and "whip" will result.

Another factor to be considered when determining the size of a shaft is the distance between bearing

centres. This is often dependent on the type of roof or ceiling construction employed in the shop. Further, it should always be remembered that where the drive is applied to the middle of a shaft instead of at one end, the diameter of the shaft may be reduced accordingly. That is to say, supposing a line shaft supplies power to a battery of twenty machines. If the power is applied to the centre of that shaft, then it need only be of sufficient diameter to convey power to ten machines on either side of the source of power, whereas, if the power were applied to one end, the shaft would need to be large enough to convey power to twenty machines.

Where possible, the main drive should be applied horizontally, that is, if a motor is employed, then this should be mounted on a level with the shafting.

Couplings.

Of the next factor in the transmission system, namely, the couplings for joining two lengths of shafting, not very much can be said. It is always necessary, of course, to see that there are no projecting parts on a coupling. Again, if two lengths of shafting of different diameters are to be coupled, it is always economical practice to turn the larger one down to conform with the smaller, so that a smaller coupling may be used.

Bearings.

A source of considerable loss in power in the transmission system is in the line shaft bearings. Here, friction necessitates the generation of additional power to overcome it and to do useful work. It follows, therefore, that considerable care should be employed in the choice of bearings. Naturally, not one type of bearing is the most suitable under all conditions, but every one will suit a particular need, and it will pay to investigate these types. Generally speaking, bearings may be divided into two main classes; those having a sliding contact, and those having a roller contact. In the first class may be placed white metal and similar bearings, while the latter class covers the various types of ball and roller bearings. The ideal bearing design is to construct the bearing that a film of oil is always between the two surfaces. In the sliding contact bearings the bearing surface of white metal is soft, and is smoothed by the turning of the shaft. Another advantage of using a soft metal lining is that, should the lubrication system fail and the bearing become heated, the metal will melt out before the shaft is in any way damaged.

Ball and Roller Bearings.

A great advantage in the rolling contact bearings is that the resistance to starting up is very slight. This is important, for, if a motor be the source of power and the resistance heavy, such motor will need to be powerful enough to drive the installation plus the resistance to starting, whereas, if this resistance be slight, then a motor merely sufficiently powerful to operate the system will suffice.

A great deal has been said about the respective merits of hardened and unhardened roller bearings. As far as the writer's experience goes, however, the hardened rollers give better service than the unhardened, and are not so liable to distortion in the event of changing loads on the shafting.

Some ball bearings are made so that the weight rests on three balls simultaneously. The essential difference between a ball and a roller bearing is, that in the former the load is carried by a point or points, and in the latter it is carried by a line.

The means of suspending the shafting is the next consideration; this is accomplished by brackets or hangers. There is, again, a considerable range from which to select, and no difficulty should be experienced in finding just the type to suit a particular need. The same may be said of shaft pulleys.

From Shaft to Machine.

The most important of the remaining power transmission factors is the means of conveying the power from the shaft to the machine, *i.e.*, by belt, chain, or rope. In spite of the steady advance in the use of chains, the majority of manufacturers still cling to the belt.

Belts.

It is here, perhaps, that a great deal depends on the judgment of the engineer-in-charge in selecting his belt. The first thing to do is to study the conditions under which that belt is expected to serve. Here, again, there is a belt which will give the best service under one set of conditions, but it cannot be expected to give equal service under any and all conditions. For instance, the engineer must know what horse power he wants that belt to convey, at what speed it is to run, the distance between pulley centres and so forth.

He must find out whether the belt will be exposed to chemicals, acids, steam, or oil. He should also investigate the claims of the various types of belt, leather, rubber, cotton, and so on. Each of these belts, when properly handled, will give excellent service where the conditions are favourable, but no one, for instance, where the belt would come into contact with oil, would select one of rubber.

Again, a belt should always, where possible, be spliced and cemented in preference to clamping or hooking. If the latter course be adopted, then this joint will be the weakest part of the belt, and will give rise to continual trouble.

It is now the aim of modern engineers to run a belt as slack as possible, so as to obtain a greater arc of contact on the pulleys. To effect this successfully and without incurring loss of power through slipping, some compound, which is non-acid and non-alkali, must be used to give the belt the property of clinging.

The horse power transmitted by a belt varies with the speed in feet per minute at which it is run. This statement will hold up to a speed of about 3,500 ft. per minute; here centrifugal force is encountered, which lifts the belt from the pulley face and slip is incurred. To combat this force the belt must necessarily be strong.

When a belt is once installed, great care must be taken to keep it in good running order. It will need inspecting after having run a few hours, and will probably need tightening up. The necessity for this operation will be fairly frequent until the newness has worn off. After this period belts should be inspected at regular intervals; also, they should be thoroughly cleaned periodically. Further, the belt should be tested for slackness by means of a tension balance.

Chain Transmission.

During recent years the chain has become immensely popular for factory transmission purposes.

There is, of course, no opportunity for slip when using a chain, the drive being positive. A chain drive should always be used when the driving centres are close together, say about three feet or less, as a belt in such a case would be too stiff and would not conform regularly to the pulley surfaces.

Where high speeds are necessary, chains must give place to belts. Further, the author has found that a belt is more suitable when varying loads are encountered, as, in this case, a certain amount of slip or "give" is advantageous.

It should be remembered that it is always advisable to provide for adjustment between shaft centre where a chain is used. The drive should be placed as close to a bearing as possible, the shafts must be parallel and lie in a horizontal plane, and all end-play must be reduced to a minimum.

One of the most important points in the successful operation of a chain is the thorough oiling of the joints. To attain this one of the best methods is to run the chain in an oil bath provided with a splash guard. Another very successful means is fixing a drip lubricator, so that the oil falls on the inside of the running chain.

Another important point is that a chain should never be allowed to run slack, this is indicated by whipping. To deal with this a link should be removed from the chain or the centres adjusted.

Rope Drive.

Rope drives are much in favour in weaving and spinning mills. Their use has not been confined here as they are now very successfully employed in other directions, notably in dynamo driving and for travelling cranes. For these purposes the cotton ropes are the most popular, and will last many years with careful operation.

Lubrication.

No remarks on power transmission are really complete if lubrication is not taken into account. A lubricant is some substance for holding apart two surfaces, normally in contact, and which surfaces would cause friction to be set up with consequent inefficiency in running. From this it must not be understood that any liquid would do. What is most important is that the lubricant should maintain this film under pressure and at high temperatures. In this connection the chemical composition and flash-point of the oil are most important. The main physical characteristic is the viscosity.

Lubricants are manufactured of widely different consistencies and qualities to meet correspondingly widely different needs. Light machinery and high speeds need light oils; heavy machinery turning at low speeds require heavy or "stiff" lubricants, heavy oils, greases and so forth.

This is where a works chemist plays an important part. It should be part of his routine to test different lubricants, oils, greases and graphite, and specify these for different purposes. When the best lubricant for each type of machine has been found, then a good stock of this should be kept and labelled accordingly, so as to avoid confusion.

Regular Inspection.

No transmission system, however well installed, can be run profitably and efficiently without some regular system of inspection. For this purpose, employees should be detailed to care for the system; to inspect shafting, pulleys and belts regularly, and to effect repairs or lubricate the bearings and chains when required. Only by keeping continual watch on the power transmission units can a breakdown be anticipated and avoided, and consequent loss in production obviated.

DESIGN AND APPLICATIONS OF "HIGH-SPEED GEARING."

By M. Coronel.

(Continued from page 287.)

Light Double Reducing Gears.—These are made on similar lines to the preceding gears, but have two reductions. They have, therefore, two sets of wheels and pinions and three shafts. The usual arrangement can be seen from Fig. 2. The first motion or high-speed pinion shaft is carried by two bearings, one an outside, and one an internal bearing, each situated close to the pinion. This pinion gears with the second motion wheel keyed on a shaft, which carries also the second motion pinion. The primary reduction shaft has three bearings arranged as shown in Fig. 2. The second motion pinion gears into the slow-speed

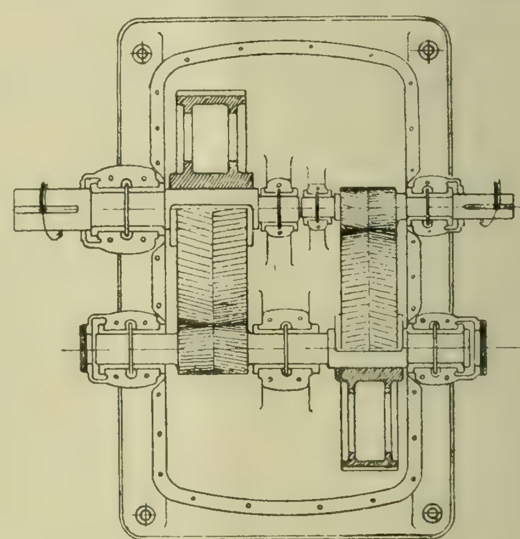


Fig. 2.—Double Reducing Gear Light Type.

gear wheel keyed on a shaft, which may be situated in line with the high-speed shaft. The slow-speed shaft is carried by two bearings situated close to the gear wheel to avoid undue bending. The whole is enclosed in a cast-iron casing, split horizontally, and having the bearings cast thereto. In the smaller sizes the outside bearing caps form part of the top-half casing. In the larger sizes the bearing caps are all independent of the casing, and can be removed separately. The bearings are ring-oiling bearings of ample size, generally 2 to 2½ diameters long, and made of phosphor bronze.

The construction of the gear wheels is of a strong design, the rim and boss being reinforced by flanges running into the arms, which are I section.

Below are given a few useful formulæ in connection with the design of these wheels. (See Fig. 3.)

DEFINITIONS.

P = circular pitch.
T = number of teeth.
A = thickness of rims $\frac{P}{2}$
B = width of arm $= (\cdot015 \times T \times P) + 1\cdot5$.
C = diameter of boss = bore $+ 2P$ between webs of arms.
D = depth of arm = face width $- \frac{P}{2}$
E = thickness of metal in arm at rim $= \cdot44P$ . . . Max.: $1\frac{1}{2}$ in. $+ \frac{1}{16}$ in. per foot diameter of wheel.
F = radius of key patch $= P$.
G = thickness of metal in boss $= P$.
H = height of flange on boss $= P$.

J = depth of flange on rim = P.
K = thickness of metal in arm web = ·375P. Max. = $1\frac{1}{2}$ in
L = amount boss projects beyond face width at each side

$$= \frac{\text{Diam. of wheel in inches}}{50}$$

Number of arms 4 for wheels up to 30 in. diameter
" 5 " " 42 in. "
" 6 " " 96 in. "
" 8 " above 96 in. "

Diameter of bolts at rim in split wheels :

	Cast-iron wheels.	Cast-steel wheels
For one bolt	D = ·109 PF.	D = ·262 PF
For two bolts	D = ·054 PF.	D = ·131 PF..

Diameter of bolts at boss in split wheels :
D = diameter of bolts at rim + $\frac{1}{4}$ D.
Formula for diameter of shaft to equal strength of teeth :

$$D = \sqrt[3]{\cdot 000169 \times S\,P.\,\mathrm{Dia.}}$$

Also
$$D = \sqrt[3]{\frac{HP \times 321000}{\mathrm{R.P.M.} \times fs.\ (\mathrm{lbs.\ sq.\ in.})}}$$

S = strength of teeth from tooth formula (Lewis's, etc.).

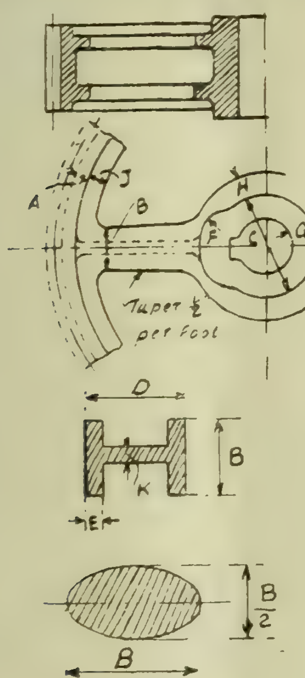


FIG. 3.

The safe horse power which double helical gears will transmit is expressed by the following formula :

$$\mathrm{H.P.} = \frac{\mathrm{P.A.W.C.B\,C.S.}}{1000}$$

P = circular pitch.
A = a factor depending on the circumferential speed (see Table 1).
W = face width in inches.
B = value depending on pressure angle and on number of teeth (see Table 2).
C = a factor depending on the material (see Table 3).
S = speed of pitch line in feet per minute.

The ratio of the safe horse power of cast-iron wheels to that of cast-steel wheels = 1 : 2·2.

Wheels of the construction shown in Fig. 4 are made for very high speeds, and are a solid type. For wheels up to 18 in. diameter disc wheels are used. Minimum length of arms of wheels = 6 in. For split wheels at least two bolts should be used at rim.

The pinions are cut out of the solid shaft, which, for this purpose is made of special ·4 per cent carbon pinion steel. If the pinions are relatively large, they are made separately of this material and keyed on a mild-steel shaft. These pinion shafts and wheel shafts have enlarged sizes on one side only, to fit close to the ends of the bearing. The other end is free to move if expansion occurs. The casings have inspection covers, oil-level gauges and drain cocks, and means of replenishing the oil. The large wheels dip in about 2 in. of oil; the oil is carried along with the wheel and serves to lubricate the gears. This method is, as before mentioned, sufficient for a circumferential speed not exceeding 1,000 ft. per minute. Above that speed cavitation sets in, and spray lubrication must be resorted to. The bearing oil is kept separate from the oil in the casing.

TABLE I.

Speed of the Pitch Line ft. per min.	Values of A.
100	15
300	12·5
500	10·25
700	8·5
900	7·25
1,100	6·5
1,300	5·88
1,500	5·63
2,000	5·13
2,500	4·63
3,000	4·13
3,500	3·63
4,000	3·13
4,500	2·63
5,000	2·13

TABLE II.

No. of teeth.	Values of B. Pressure Angle. $14\frac{1}{2}°$	20°
12	·67	·78
14	·75	·89
16	·87	·97
20	·90	1·08
24	·94	1·14
29	·99	1·20
37	1·04	1·27
49	1·08	1·33
59	1·10	1·36
74	1·13	1·39
94	1·15	1·42
150	1·17	1·45
300	1·20	1·48
400	1·22	1·51
Rack	1·24	1·54

TABLE III.

	Values of C.
Raw Hide	·80
Compressed Paper	·70
Mortice Wheels	·80
Cast Iron	1·0
Phosphor Bronze	1·6
Cast Steel	2·2
Mild Steel	3·0
·4 per cent Carbon Pinion Steel	4 to 5

Single heavy type reduction gearing, as used for rolling mills, haulage gears, conveyors, colliery tramways, etc.

This type has a strong box section bedplate, on which are mounted independently four ample sized ring-oiling pedestals

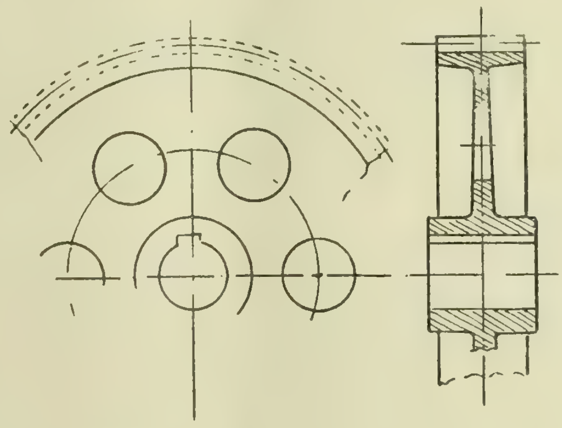


FIG. 4.

carrying the pinion and wheel shafts. The pedestals are dowelled and bolted to the bedplate and held by large lugs cast on the bedplate. Steel keys fix the distance between the shaft centres. The pinion and shaft are, as before, made in one piece for small pinions, while for larger sizes the pinion is made separately and keyed on.

The large wheel is either made from cast iron or cast steel, with I section arms, according to size and the horse power to be

transmitted. It is keyed on an enlarged part of the shaft. On each side of the wheel are situated cast-irin or wrought-steel oil throwers to prevent the oil from the bearings being sucked along the shaft by the fan action of the gear wheel, and to prevent the heavier oil carried by the wheel from running along the shaft to the outside of the casings.

The pinion is made of ·4 per cent carbon steel with about 3 per cent nickel added. The pinion shaft, when it is not made in one piece with the pinion, is made of mild steel, and is enlarged at that part where the pinion is keyed on.

Oil throwers of mild steel or brass, not cast iron on account of the high speed, are fitted close to the pinion to keep the oil in the casing. The wheels are enclosed in a wrought-steel or cast-iron casing, split horizontally and bolted together, forming an oil-tight joint. The pedestals are entirely outside, and independent of the casing, and are, as stated above, securely bolted down to the bedplate, to which also the casing is bolted with strong lugs. The sides form an oil-tight joint with the casing.

It should be mentioned that in larger gears, and those running at a high speed, the sections of the gear wheel rim, and also the metal of the casing, especially if made of steel, should be ample so as to prevent them from "ringing," which is a noise due to the speed and vibration in the gear. For the casings, $\frac{1}{8}$ in. for small sizes and $\frac{1}{4}$ in. sheet steel for large sizes has been found suitable. Cast-iron casings are usually made from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. thick.

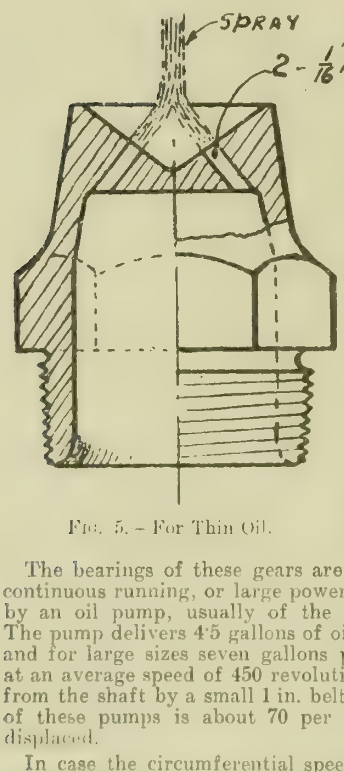


Fig. 5.—For Thin Oil.

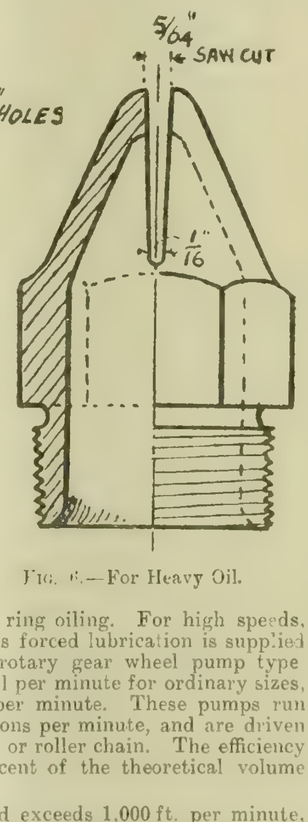


Fig. 6.—For Heavy Oil.

The bearings of these gears are ring oiling. For high speeds, continuous running, or large powers forced lubrication is supplied by an oil pump, usually of the rotary gear wheel pump type The pump delivers 4·5 gallons of oil per minute for ordinary sizes, and for large sizes seven gallons per minute. These pumps run at an average speed of 450 revolutions per minute, and are driven from the shaft by a small 1 in. belt or roller chain. The efficiency of these pumps is about 70 per cent of the theoretical volume displaced.

In case the circumferential speed exceeds 1,000 ft. per minute, sprayer lubrication of the gear wheel is resorted to. A pump of similar design to that used for the bearings, and driven from the shaft, as before, takes its oil from a reservoir in the bed plate and delivers same through a row of spraying nozzles on the in-running side of pinion and wheel over the whole length of the face.

The direction of the spray is about half the angle made by the pinion and wheel at that spot. The shape of the nozzle is such that the jet is in the form of a swallow tail, like an ordinary slit gas burner jet. The construction of such nozzles can be seen from Figs. 5 and 6. Several nozzles, or pairs of nozzles, are erected on a nozzle holder so as to give a continuous flat stream on the gear teeth.

These gears have on the high-speed side, generally a flexible coupling, either of the rubber bush type or flexible claw pattern. The low speed side has usually a solid flange coupling.

(To be continued.)

NEW LOCOMOTIVE FUELS.

Experiments are being made by the railway companies in order to find an economical substitute for the coal at present used in locomotive engines. They are in continuation of experiments which were already being made before the war. Some of the most successful of the earlier results were obtained by the Great Eastern Company, who fitted up a number of engines for burning oil of a low-grade quality. The results were regarded as satisfactory, but when the price of oil went up, and it became more expensive than coal, the engineers went back to coal.

The increasing price of coal and other causes have led to a resumption of the experiments, and Mr. J. G. Robinson, the chief mechanical engineer of the Great Central Company, has lately produced successful results by the use of two new kinds of engine fuel. One is powdered, or pulverised, low-grade coal; the other a mixture consisting of 60 per cent pulverised coal and 40 per cent low-grade oil.

"Some three and a half years ago I began to experiment with lower-grade coal," said Mr. Robinson recently to a representative of the *Manchester Guardian*, "with the object of cheapening the cost of locomotive working. Coal burnt in the engines varies a good deal in quality, and some of the qualities are difficult to work. It is the grades containing a certain percentage of calorific power that are being used in a pulverised form, and a locomotive of the most powerful type fitted up for the use of pulverised coal is working one of the heaviest trains on the line. I was of the opinion that coal of this type could be advantageously used with oil, and I turned my attention to the colloidal mixture of pulverised coal and oil, and ultimately fitted up an engine of similar type to the one we were using for powdered coal.

A SEARCHING TEST.

"It was discovered during the experiments that the ordinary burner for oil in furnaces, although satisfactory with ordinary oil, could not be used with the colloidal mixture, and I had therefore to design a new burner. The experiments proved so satisfactory that I decided to test three engines of the same class—eight-wheel coupled mineral train engines—in order to ascertain the comparative results obtained with bituminous coal, with powdered coal, and with the coal and oil mixture. These engines were tested, each drawing 80 wagons. A Sunday was chosen for the test, so that there could be, without interruption, a non-stop run from Manchester to Dunford through the Woodhead Tunnel—a distance of 20 miles, with a ruling gradient of one in 120. That route was adopted as being one of the most severe tests a locomotive could be put to.

"The trains started one after the other, with a 12 minutes' interval. The results proved conclusively that the engines burning the pulverised coal and the mixture worked the train exactly in the same time as the engine using bituminous coal, with a full head of steam the whole distance. Only a thin grey smoke came from the engines using the new fuels, showing thorough combustion, whilst the black smoke from the ordinary coal could be seen a long distance away. There were no ashes from the engine using the mixture."

Mr. Robinson pointed out that his object was to get rid of many difficulties which exist to-day in working locomotives. The fireman on the large engines had an arduous job in dealing with ash and clinker, and there was necessarily a great waste of coal and calorific power. There was a good deal of labour, too, involved in putting away and cleaning locomotives, and in doing so, cold air was admitted into the fire-boxes, which caused contraction of plates and future trouble. With the new fuels he claimed that these difficulties were removed. A pulverising plant has been erected at Gorton, by which a variety of materials can be converted into engine fuel. Anthracite can be used if mixed with a certain percentage of bituminous powdered coal, but not alone.

AN INTERNATIONAL QUESTION.

"I am not going to fit up any more engines," said Mr. Robinson, "until I have experimented on all kinds of fuel, but I should not be afraid, on the results of the recent experiments, to run a train on the new fuels between Manchester and London." Many engineers from foreign countries have already been to Gorton for information, including representatives from Ceylon, India, the Argentine, and Brazil, and requests for designs have been received from the Italian and Portuguese Governments. In all these countries the coal question is acute. The expense of converting an ordinary railway engine into one for the use of pulverised coal is not considerable. The fuel is contained in a

hopper built into the tender, from which it falls by gravity on to the two-feed screws which carry it forward through pipes and chambers. It is ignited through the inspection doors, by burning a piece of cotton-waste soaked in petroleum in front of the nozzles through which it is blown into the firebox. The doors are closed before the feed of fuel is started. Everything is done to facilitate combustion. It is pointed out that the value of the new fuels will vary with the condition of the coal and oil supply in the countries in which they are used. In this country the colloidal mixture appears to have the best prospects of application, as the installation it requires is the cheaper.

The London and North-Western Railway Company have also taken up the question of oil fuel. Captain Beames, the manager of the company's locomotive works at Crewe, informed a representative of the *Manchester Guardian* that an engine is being fitted with an oil-burning apparatus, and experiments will shortly be made. The installation is more on the lines of the Great Eastern tests than on those of the Great Central already described. Crude oil is to be burned, but the type of burner is new.

VIBRATION OF STEAM BOILERS.

By EDWARD INGHAM, A.M.I.Mech.E.

WHILST we often hear of trouble from vibration of engines and other revolving machinery, it is comparatively rarely that trouble is experienced from this cause in connection with steam boilers. The trouble does, however, occasionally occur, and when it does, is rather alarming.

Causes of Vibration.

The causes of vibration of steam boilers are not easy to discover, but it will be interesting to consider one or two of the more common causes. The trouble in question is probably most commonly experienced in connection with large Lancashire boilers, and in most cases is due to baffling of the furnace gases at the back end of the boiler. As the two streams of gas flowing along the furnace and flue tubes come together at the back end, the action is not unlike the rolling together of the clouds which gives rise to thunder, and unless means be taken to prevent it, a tremendous noise will result, and the boiler will vibrate to an alarming extent. The nuisance is, of course, avoided by building an anti-baffling wall in the centre of the down-take, and carrying this a few feet under the boiler towards the front end. With this provision, the two streams of gas are prevented from meeting each other until their direction of flow has been reversed, and they are well on their way along the bottom flue towards the front end.

Water Hammer.

Another cause of vibration appears to be the water hammer action, which is sometimes set up in the fuel economiser pipes as the result of stoppage of the water circulation. It will be understood that should the water be allowed to remain stationary in the pipes of the economiser, there is a tendency for some of it to be evaporated into steam, in which case the level of the water will fall, and the upper portions of the pipes may thus become overheated. Water hammer action is then liable to be set up, and a vibration may be transmitted to the boiler, which in consequence vibrates to a more or less serious extent. Both Lancashire and water-tube boilers may be affected in this way.

This trouble usually occurs in connection with boilers where the load is of a very fluctuating nature. For example, at electric light stations, the load may at one period be very light, and at another unduly heavy. Under the light loads the feed supply is sometimes turned off, when overheating may result in the manner explained. When a heavy load comes on, and the feed valve is again opened, the water coming into contact with the steam in the pipes sets up water hammer action and severe vibration, which, on being transmitted to the boiler, through the medium of the pipes, gives rise to vibration of the boiler itself.

Effect of Cold Air Currents.

In one instance of vibration which came under our notice, a water-tube boiler gave a great deal of trouble, the vibration being so severe that the dampers had to be partly closed down. The boiler was fired by a chain grate stoker of the Babcock and Wilcox type. The trouble appears to have been due to the use of an unusually clean coal. This coal, after combustion, left no clinker or ash, so that the grate at the back end, after the coal had burned away, was left bare. This allowed cold air to rush through in large volumes, and impinge on the hot water tubes. Probably the cooling effect of the cold air, and the consequent contraction of the tubes, set up the vibration. The trouble was not experienced when a dirtier coal was used; apparently because the ash and clinker served to cover up the grate, and so prevent cold air from rushing through.

In order to overcome the trouble without changing the coal, the fires were thickened and the dampers partially closed down. The effect of this was to prevent the coal being completely burned through until it had reached the end of the grate, and this effectively cured the mischief.

STEAM TABLES.

(Continued from page 295.)

IT remains to state on what sources these tables are founded. All the figures in Table 1, 2, 3, 4(*a*), 4(*b*) have been calculated from the figures given in Prof. Peabody's "tables of the properties of steam and other vapours," eighth edition, 1912. In the present tables all steam pressures are given as gauge pressures, not as absolute pressures, which is the usual practice. The use of absolute pressures is certainly the more scientific, since it does not require the fixing of a somewhat arbitrary starting point, but, for use in connection with boiler-house calculations, it is more convenient to have a table based directly on the gauge pressures, thus avoiding the continual addition or subtraction of the atmospheric pressure when using the tables. The atmospheric pressures, not as absolute pressures, which is the usual practice. The gauge pressure = absolute pressure − 14·7.

The figures in Table 4(*c*) depend on the total heat required to raise 1 lb. of saturated steam at a known pressure through a known number of degrees above the temperature of saturation. This quantity may be called the "superheat units" in the steam. It is not known with the same accuracy as are most of the other properties of steam. Both Prof. Peabody and Messrs. Marks and Davis base their figures as to the total heat of superheated steam on the results of experiments made in 1906 by the German professors Knoblauch and Jakob. These experiments give, perhaps, the most reliable results so far obtainable; they are, however, not entirely sastisfactory, and it is to be hoped that further research on this important subject will soon be undertaken by one of our own universities or scientific institutions. It is now known that the scientific heat of superheated steam is not a constant, but varies both with the pressure and with the amount of superheat. Since the specific heat is thus a function of both variables, and since we have, as yet, no clear theoretical guide to the form of the function, we can only depend on the results of experiment, either using these results directly in the form of a table, or indirectly, as the basis for an empirical equation which will give a more or less close

TABLE I.

Temperature of saturated steam, in degrees Fahrenheit.

P(g) = Gauge pressure, in lbs. per square inch.

P(g)	0	1	2	3	4	5	6	7	8	9
3..........	274·04	275·41	276·76	278·08	279·37	280·65	281·91	283·15	284·37	285·57
4..........	286·74	287·90	289·06	290·19	291·31	292·41	293·50	294·56	295·62	296·66
5..........	297·69	298·71	299·72	300·71	301·70	302·67	303·63	304·58	305·51	306·44
6..........	307·36	308·27	309·17	310·06	310·95	311·82	312·68	313·54	314·38	315·22
7..........	316·05	316·87	317·69	318·49	319·29	320·08	320·87	321·65	322·42	323·18
8..........	323·94	324·69	325·44	326·18	326·91	327·64	328·36	329·08	329·80	330·51
9..........	331·21	331·90	332·59	333·27	333·96	334·63	335·30	335·97	336·63	337·29
10..........	337·94	338·59	339·23	339·87	340·50	341·12	341·75	342·37	342·99	343·61
11..........	344·21	344·82	345·42	346·02	346·61	347·20	347·79	348·37	348·96	349·53
12..........	350·10	350·67	351·24	351·81	352·37	352·93	353·48	354·05	354·59	355·13
13..........	355·67	356·21	356·75	357·28	357·81	358·34	358·86	359·38	359·90	360·42
14..........	360·93	361·45	361·96	362·47	362·97	363·47	363·97	364·47	364·96	365·45
15..........	365·94	366·43	366·92	367·40	367·88	368·36	368·83	369·31	369·78	370·25
16..........	370·72	371·18	371·64	372·10	372·56	373·02	373·48	373·93	374·39	374·83
17..........	375·28	375·73	376·17	376·61	377·05	377·48	377·92	378·36	378·79	379·22
18..........	379·65	380·07	380·50	380·92	381·34	381·76	382·18	382·60	383·02	383·44
19..........	383·85	384·27	384·68	385·09	385·49	385·90	386·30	386·70	387·10	387·50
20..........	387·90	388·29	388·68	389·08	389·47	389·86	390·25	390·64	391·03	391·41
21..........	391·80	392·18	392·56	392·93	393·31	393·69	394·07	394·45	394·82	395·19
22..........	395·56	395·93	396·30	396·67	397·03	397·39	397·75	398·11	398·48	398·85
23..........	399·21	399·57	399·93	400·29	400·64	401·00	401·35	401·69	402·04	402·38
24..........	402·73	403·07	403·42	403·76	404·11	404·45	404·79	405·13	405·47	405·80
25..........	406·13	406·47	406·80	407·13	407·47	407·80	408·13	408·47	408·80	409·13
26..........	409·47	409·80	410·13	410·45	410·77	411·09	411·42	411·74	412·06	412·38
27..........	412·69	413·00	413·31	413·63	413·94	414·25	414·58	414·90	415·22	415·53
28..........	415·85	416·15	416·46	416·76	417·06	417·36	417·67	417·97	418·27	418·58
29..........	418·88	419·17	419·47	419·76	420·06	420·36	420·67	420·97	421·26	421·56
30..........	421·85	422·15	422·44	422·73	423·02	423·31	423·60	423·89	424·17	424·46

It will be observed that only one table is published in this issue. The other tables mentioned will appear in the subsequent numbers.

approximation to the true value of the specific heat. This matter may be most clearly stated symbolically, as follows :—

Let P(g) = gauge pressure of steam, in pounds per square inch = absolute pressure 14·7 ;

T = saturation temperature corresponding to pressure P(g), in degrees Fah. ;

T(s) = actual temperature of superheated steam, in degrees Fah. ;

n = number of degrees Fah. of superheat = T(s) − T ;

H(s) = number of B.Th.U. required to raise 1 lb. of steam at constant pressure P(g) from temperature T to temperature T(s) ;

C(p) = mean specific heat of steam at constant pressure P(g) over temperature range T to T(s) = H(s)/n.

It is required to know the value of H(s) for any given values of P(g) and n. Since H(s) = C(p) × n, this value is known if the mean specific heat is known. Prof. Peabody quotes some figures from Knoblauch and Jakob's experiments, showing variation in the value of C(p) from ·462 to ·677; in Marks and Davis's tables a curve is given which indicates still larger variation. The highest values of C(p) correspond to high pressures and low superheat. It is obviously a great practical convenience to assume a constant value for C(p), provided that such assumption does not cause the introduction of such errors into the value of H(s) as to vitiate the calculation of boiler test results, efficiency guarantees, etc. The constant value C(p) = ·55 has for some time been generally used by engineers, and it will be of interest to see what error the use of this value introduces into the calculated values of H(s), as compared with the true values deduced from the results of experiment. A table is given on the next page, which shows, first, the true value of H(s) as derived from Knoblauch and Jakob's results; and, secondly, the error caused by the assumption H(s) = ·55 × n. These figures are given for selected values of the pressure and the superheat, chosen so as to cover the range of ordinary practice ; P(g) is taken from 100 to 300 at intervals of 50 lb. per square inch, and n is taken from 50 to 300 at intervals of 50 deg. Fah. The error is shown as positive when ·55 × n gives a value greater than the experimental value of H(s), and as negative when ·55 × n gives a lower value; thus the experimental value is obtained by subtracting (that is eliminating) the error from the calculated value, ·55 × n.

TABLE COMPARING THE EXPERIMENTAL VALUE OF THE SUPERHEAT UNITS IN STEAM WITH THE CALCULATED VALUE, ON THE ASSUMPTION OF A CONSTANT SPECIFIC HEAT EQUAL TO ·55.

P(g) =		100	150	200	250	300
n = 50	H(s)	28·1	30·2	32·4	34·6	36·8
	Error	− ·6	− 2·7	− 4·9	− 7·1	9·3
100	H(s)	54·3	57·0	59·8	62·3	64·8
	Error	+ ·7	− 2·0	− 4·8	− 7·3	− 9·8
150	H(s)	79·4	82·6	85·4	88·1	90·7
	Error	3·1	·1	− 2·9	− 5·6	− 8·2
200	H(s)	104·2	107·5	110·5	113·3	116·1
	Error	5·8	+ 2·5	− ·5	− 3·3	− 6·1
250	H(s)	128·5	132·1	135·2	138·2	141·1
	Error	9·0	+ 5·4	+ 2·3	− ·7	− 3·6
300	H(s)	152·7	156·5	159·9	163·0	166·0
	Error	+ 12·3	+ 8·5	+ 5·1	+ 2·0	− 1·0

The above table shows that the error introduced by the assumption that C(p) is always equal to ·55 is sometimes positive and sometimes negative, the greatest positive error (within the range shown) being + 12·3 B.Th.U., and the greatest negative error 9·8 B.Th.U. These errors are less than 1 per cent of the total heat in the steam, and may be considered within the limits of uncertainty in ordinary practical boiler tests, when considered in relation to the total heat required for evaporation, but when it is

a question of calculating the work done by the superheater apart from the rest of the heat, then the error introduced is much larger relatively, and ought to be taken into account. In Table 4 (*c*) the constant value $C(p) = \cdot 55$ has been used; consequently the tabular values are equal to $n \times \cdot 55/969\cdot 7$, or $n \times \cdot 0005672$.

In regard to Table 4(*b*), it should be noted that the arrangement adopted is such as to avoid the necessity of subtraction, and thus to reduce the work involved. The "factor of equivalent evaporation" may be defined as the number of evaporation units required to convert 1 lb. of water at a known temperature into 1 lb. of steam at a known temperature and pressure. One evaporation unit is equal to 969·7 B.Th.U., according to Prof. Peabody's tables, being the heat required to convert 1 lb. of water at 212 deg. Fah. into saturated steam at the same temperature. Taking, as usual, water at 32 deg. Fah. as the starting point, there are three quantities to be considered: (1) The heat required to convert 1 lb. of water at 32 deg. Fah. into saturated steam at the given pressure; this is denoted by H, and the values are given in Table 2; (2) the heat (above 32 deg. Fah.) already in the feed water entering the boiler at the given feed-water temperature; this is denoted by $H(w)$, some writers use the symbol (h), and the values are given in Table 3; (3) the heat required to superheat the saturated steam to the given temperature; this is denoted by $H(s)$, and the values are not directly tabulated, but the influence of this quantity on the evaporation factor is given in Table 4(*c*). Knowing the values of H, $H(w)$, and $H(s)$, the formula for the evaporation factor F, is :—

$$F = \frac{H}{969\cdot 7} - \frac{H(w)}{969\cdot 7} + \frac{H(s)}{969\cdot 7}$$

The direct use of this formula involves the subtraction of the second term, but it may be put into the equivalent form :—

$$F = \left\{ \frac{H}{969\cdot 7} - 1 \right\} + \left\{ 1 - \frac{H(w)}{969\cdot 7} \right\} + \frac{H(s)}{969\cdot 7}$$

This form of the formula for the evaporation factor looks much more complicated, but it renders the use of the table easier by getting rid of the subtraction of the second term, which now becomes an additive term, like the two others. Therefore, in the tables now printed, Table 4(*a*) gives the value of $H/969\cdot 7 - 1$; Table 4(*b*) gives the value of $1 - H(w)/969\cdot 7$; Table 4(*c*) gives the value of $H(s)/969\cdot 7$. The value of the evaporation factor is obtained (as shown in the example given above) by adding the appropriate values taken from the three sections of Table 4. Of course, if there is no superheating (that is, if saturated steam is in question) Table 4(*c*) is not required.

It is believed that the above notes will supply all the information needed for the use of the tables to the best advantage so as to get from them readily any figure required. If any user finds that some point has been passed over or inadequately explained, we invite him to write to us, and will endeavour to make such matter clear.

(Concluded.)

Review.

EFFICIENT BOILER MANAGEMENT. By Chas. F. Wade, A.M.I.E.E. London: Longmans, Green and Co.

In reviewing a treatise of this class one naturally turns primarily to the preface, hoping to find set forth there the author's aims. In this instance they are very plainly stated. He proposes to deal with the scientific principles underlying steam-raising problems so that the average engineer or works manager will understand them, and he suggests that all previous treatises fail to do this. We are satisfied, after careful perusal of the book, that the author knows his subject well by study and experience, but we emphatically deny his assertion that the subject has not been handled previously, and in a manner more likely to assist the particular class to which he addresses himself. The author includes much useful information, but lacks that discrimination and directness so essential to his declared aims. By comparison, Mr. W. H. Casmey's modest little production, "Coal Economy" (Griffin and Co.), appears to us to excel it by far in direct utility, for the latter gentleman not only understands his subject, but also his audience. The treatise is very much like the curate's egg. Chapters on fuel and the theory of combustion are well written, straightforward, and simple, and the practical notes upon boiler-furnace manipulation carry conviction as being obviously the direct outcome of personal experience.

Practically half the book, however, is given up to illustrations and very brief descriptions of apparatus and instruments which might well have been omitted, seeing that the same illustrations appear in the advertisement pages of nearly all engineering journals, and descriptions thereof are far more complete and satisfactory in the respective makers' catalogues; and this portion is the more unsatisfactory in that the apparatus described is not always representative of the most usual practice, while practically no help is given to the reader in discriminating. As examples of this, no less than five types of calorimeter for ascertaining coal values are described, but there is hardly the suggestion of advice as to which of them the reader should choose for his particular conditions. The same remarks apply in regard to draught and temperature recording, gas testing, and water-measuring instruments; even supposing that the average British manufacturer may some day be brought to understand that intelligent control of his boiler-house will pay (and this day appears still remote) he will be dismayed rather than assisted by the author's long list of "necessaries."

We have endeavoured unsuccessfully to determine just how far the author would recommend the steam user to go in his scientific organisation, for it must be remembered that, for every factory requiring 1,000 H.P. or over, there are hundreds requiring lower powers. Several examples of most elaborate log sheets are submitted, modelled upon those of our largest and best managed electrical stations, and the following boiler-house working staff is suggested: Leading firemen, firemen, ash wheelers, leading boiler cleaners, leading fitters, fitters, fitters' mates, pipe-fitters and mates, pipe-cover and mate, labourers and cleaners.

This list follows a paragraph suggesting that about 30 boilers (type and capacity not stated) is the limit for supervision of one shift engineer. No doubt! Perhaps this organisation is quite good for an heroic super-power station, but nowhere in the book, so far as we can see, are the relative suggestions set forth for "the average engineer or works manager," to whom the preface is addressed, and who are accustomed to work one or two boilers, with perhaps one engineer, one fireman, and a little casual help at holiday overhauls.

In the chapter on "Feed Water" some quite useful notes are given, but there is also much that is misleading. For example, the author suggests that analysis of feed water is "the province of a highly-skilled analytical chemist." Elsewhere he insists that complete fuel and gas analyses are "essential." We submit that adequate water analysis is child's-play compared with the proposed fuel and gas analysis, *e.g.*, Mr. C. E. Stromeyer's report to the Manchester Steam users' Association for 1903, in which, on two pages, water tests are described sufficient for all practical purposes.

The Permutit process of water softening is described at some length. This is a remarkable and interesting invention, but with limitations for boiler-house use, which should be mentioned.

The author is wholly wrong in stating that some form of oil eliminator is indispensable when exhaust steam is used in heater-softeners. As a matter of fact, such softeners, properly arranged, are themselves the best oil eliminators known, working upon the principle which he describes in the paragraph immediately following.

The table of losses incurred due to scale of various thicknesses given at the conclusion of the chapter is recognised as quite unreliable, *vide* Mr. Stromeyer's report mentioned above. So we could go on through the book, did space and time permit. We regret to deal with it so critically, but our own keenness to persuade manufacturers to adopt scientific means toward fuel economy leads us to believe that the author's wholesale proposals, as set forth, may well frighten them away. Two things, and two only, not yet commonly employed, are necessary to enable the ordinary steam user to ascertain whether he is working efficiently or no in his boiler-house. One is fuel analysis, which should be compulsorily supplied by the colliery; the other is a water meter. With these, half-a-dozen thermometers, three or four home-made draught gauges, and the occasional assistance of a chemist with a gas burette, the normal steam user may do all that is necessary in diagnosing his case and improving his working conditions. Shortly, the author knows his subject, but not his audience. T. Roland Wollaston.

April 29th, 1920.

FOREIGN ENGINEERING NOTES.

VERMONT TALC.

In the Vermont district there is only one mine at present producing talc of a grade suitable for the cutting of metal worker's crayons. At this mine, which is near Waterbury, there is found in pockets a massive variety of talc which may be used for pencils. This talc is sometimes sorted out underground, but usually is picked from the belt convenor, which carries the crude rock from bins to the crusher. The blocks of talc are taken to the sawing rooms and squared off on two opposite sides on an 18 in. circular saw. This saw is on a swinging arm, which is pulled forward by hand, cutting the talc block, which rests on a horizontal table. The faced block is then sawed with an 18 in. slab saw into slabs of the width of the pencils to be made. The slab saw and the pencil saws are circular saws revolving in a fixed position, and the talc is pushed through by hand. The thin slabs are cut into the various sizes of pencils with 12 in. and 6 in. saws. Care is taken that the grain of the talc runs the length of the pencil. After sawing, the pencils are sorted into two grades, No. 1 and No. 2. No. 1 grade must be sound and perfect in every way. No. 2 grade may be rougher, and slightly splintered at the ends.

Talc pencils at this mill are made in a number of sizes. These are packed in small wooden boxes, and the boxes shipped in large crates or cases. The trade prefers a hard, tough pencil to a soft one, as the point wears down less easily.

During the winter months trouble was experienced with talc pencils, which were made up and shipped without much drying. They were soft and broke easily. It was found that a thorough drying and seasoning increases the durability. It is thought possible that a slow baking or drying by artificial heat might improve stock not otherwise suitable for cutting.

Small blocks or cubes of soft, pure talc are used in a number of industries for polishing wood and nails. In the manufacture of small turned-wood novelties and tool handles, blocks of talc are sometimes placed with the articles to be polished in large wooden tumblers revolving about a horizontal shaft. The tumbling of the talc blocks against the wood abrades the talc, filling the pores of the wood and imparting a dull polish. The tumbling of blocks of talc with nails in a similar manner is said to facilitate the passage of nails through nailing machines used in the manufacture of wooden packing cases.

WHEN IRON GETS SICK.

In a recent issue of *Elektrotechnik und Maschinenbau*, M. Vidmar draws attention to the disastrous effects that may arise from iron filings when, through carelessness in construction, they exist in cavities in the iron cores of electrical machinery. In large units considerable voltages (of the order of a few tenths of a volt) may occur between neighbouring plates or other parts. If iron filings or chains of filings bridge across such places, very high local temperatures may obtain through the development of Joulean heat—0·2 volt would suffice to heat an iron particle to 1,000 deg. Cen. inside a fraction of a second. A burn may result where the the insulation between laminæ is destroyed. The local losses then increase, and breakdown follows in severe cases. In investigating certain cases of transformer burn-outs, the author found in the cores big lumps of solidified iron filings, forming welds across bundles of plates. This leads to the conclusion that iron sickness was the cause of these premature breakdowns.

FINE MECHANISM.

Every mechanical process, and all of the principles of design employed in the heavy engineering industries, can be traced also into what is sometimes called the fine engineering industry. Equally the converse is true, and in a historical sense especially, for it is common knowledge that most of the innovations in mechanical, electrical, and chemical engineering were first embodied and tested on the model maker's scale by men practised in watch or clock work, and numerous allied and associated branches of scientific instrument making. The classic instance of James Watt is to be recalled in this connection. But although in these days, now that the principles of applied physics have been so far systematised, much more can be done satisfactorily on paper alone than was at all possible a hundred or even fifty years ago, there is still plenty of scope for the development of useful engineering inventions through model making. Indeed, it is a matter for regret that such possibilities offering themselves in this direction have sometimes been left unexplored.

The [illegible] that [illegible] and [illegible] is what has to be [illegible] when [illegible] proposed to pass from the mechanical toy or working model to a large-scale engine. It is clear that this must be a controlling factor of design, both in applied mechanics and thermodynamics. The relations of the rate of transference of heat to the shape and volume of the heat container are important in connection with thermometric apparatus. Here the size of the instrument is a factor that obviously governs its sensitiveness; and if this matter is righly understood it will provide the explanation why internal-combustion engines are not made of the size that is advocated by eminent writers in the daily newspapers. Some air engines which are efficient as models would be quite inoperable if made on a large scale. And the same sort of thing holds true in mechanics. Flying machines, for instance, were familiar mechanical toys long before the advent of the petrol motor made possible the wonders of to-day.

BOILER INCRUSTATION.

A writer in *Les Industries du Cuir* suggests the use of graphite for preventing of scale in steam boilers. It is pointed out that the bad condition of boilers as regards scale is dangerous, inasmuch as it is the cause of explosions and leakages, etc. In addition it adds to the cost of running the boiler, on account of the extra coal required; ten to 20 per cent of the heaving value of the coal is lost when the scale reaches a thickness of 3 mm. The action of the graphite is more mechanical than chemical, and prevents the precipitate from adhering together to form hard scale.

THE LORRAINE IRON INDUSTRY.

The president of the Nancy Chamber of Commerce stated, in a recent report to the French Ministry of Commerce regarding the state of the Lorraine iron industry, that all the smelting works in the south of the Departments of Meurthe and Moselle, which have not suffered much from the war, have now resumed work in full; however, although they have been working fairly well, their production is only one-third of what it was in pre-war days. This unfortunate state of affairs is due to the transport crisis, and to the defective supply of coke. Precisely the same state of affairs exists in the Diedenhofen district. Before the war the furnaces produced over two million tons of steel, but this total has now been dropped to one-third.

RESTORING MEXICO'S RAILROADS.

Shortly after the beginning of the revolution against Huerta, in 1913, and for a long time subsequent thereto, the destruction of railroad tracks, bridges, stations, etc., became common practice in Mexico in order to hamper the movements of opposing forces. Some novel devices were employed in carrying out this destructive work, as set forth in these columns at that time. Tracks were destroyed and rebuilt over and over again, as the roads were captured and recaptured by different factions, and if destruction was rapid, so was restoration. The Mexican railroad men showed themselves experts at this sort of work, and it was a constant matter of surprise to the foreign correspondents with the Constitutionalist Army to see how quickly traffic was restored upon lines which had been so thoroughly ruined that nothing but some bent and twisted rails and the right-of-way were left.

The work of reconstruction proceeded as rapidly as the different portions of the country were pacified by the present authorities, and now every road in the Republic is in operation, with the exception of a few unimportant branch lines, while new lines have been built in several localities, bridges reconstructed, stations erected, and all this from the net earnings of the roads themselves, without calling for a dollar of outside money.

The latest lines to be restored are in the State of Morelos, so long dominated by Zapata, but entirely pacified during the past year by General Gonzales. One large bridge blown up was restored to its former position, repaired, and put in good order for traffic, and all by the use of simple appliances. The abutment upon or against which one of the spans rested was partially dynamited, and the end of the structure dropped into the ravine beneath. It is a testimony to the good character of the masonry of this abutment that hardly any of it was injured. A gallows frame of heavy timber was erected on the abutment from which the span had been dislodged, and from this a steel cable was led to a pulley attached securely to the end of the fallen span. The cable led back to a derrick car anchored to the track at the opposite end of the bridge, and passed over another pulley on the end of the derrick boom. From this it was taken to the pilot of a powerful engine, and attached thereto. When everything was "all set," signals were given, and the locomotive slowly and steadily raised the span to its original position on the face of the abutment. The men who planned and carried out this feat are justly proud of their accomplishment.

Trade Items, Notes, &c.

Petrol Substitutes.—In reply to a question addressed to the Prime Minister asking what steps he proposes to take to give effect to the Report of the Profiteering Committee that the present price of petrol is excessive and without justification, Mr. Bridgeman (Parliamentary Secretary of the Board of Trade) said: The Board of Trade propose to discuss further with the companies the various items of cost to which the Sub-committee call attention, but even if it were found possible to effect a temporary reduction, I think we must face the fact that the demand for motor spirit is growing more rapidly than the supply, and that short of a complete international control, which is hardly a practical proposal, the most effective method of preventing an increase of price is the use of other forms of liquid or gaseous fuel. The Board of Trade are examining the various possibilities with the assistance of the Fuel Research Board. There are difficulties in the way of an extended use of gas, particularly the fact that supplies of town gas are not too plentiful. I hope that it will be possible in due course to increase the production of benzol; but this, again, will be a limited quantity. The greater use of alcohol is no doubt one remedy, but a good deal of research, both as to possible sources of supply and the provision of a cheap and efficient denaturant, will be needed, and it will, I fear, in any case be a long time before large quantities can be expected to be available.

War Interrupted Studies: Concessions for Students.—The position of students whose course of studies was interrupted by the war, or by special circumstances arising from the war, has been sympathetically considered by the Council of the Institute of Metals. It has been decided to recommend for ballot, as student members of the Institute, candidates for election who, whilst being students of metallurgy, have passed the age limit of 25 years for admission to student membership. Students so elected may remain in the category of student members up to June 30th, 1923, so long as they continue to be students of a recognised school of metallurgy. This concession represents an appreciable financial saving, as a student member pays only the guinea entrance fee and guinea subscription of pre-war days. Though in operation for only a few weeks past, the arrangement, we understand, has resulted in student membership applications being received at the offices of the Institute, 36, Victoria Street, S.W.1, to a greater number than was the case in the whole of 1919. By a further concession, members and students elected at the forthcoming ballot on May 31, will not only have the privilege of membership for thirteen months, instead of the usual twelve, but will receive an extra copy of the *Journal of the Institute of Metals*, of which important publication volumes to the value of over £1,000 have been sold to non-members during the past twelve months surely an unique record for a young scientific society.

Fuel Economy.—Despite the large amount of attention ostensibly given to this subject by departmental and other official committees, tangible progress is minutely slow. We are inclined to look for more fruitful work from the technical sub-committee just set up by the Federation of British Industries. The men on this sub-committee will be specialists in the use of fuel, with fuel-saving as one of the chief aims of their everyday life; the practical side will therefore occupy the foreground in their activities. Professor Bone, F.R.S., has consented to act as chairman, and a technical assistant is being chosen to give his whole time to the work. Instead of ranging over the whole field, the sub-committee will concentrate on steam raising and gas production. We wish them good sport in the hounding down of dissipated thermal units.

Electrically-propelled Tugs.—According to "Quex," of the *Evening News*, marine motor makers are attempting to displace steam as the propelling agent of Thames tug boats, but up to the present they have not been altogether successful. With the present cost of coal the fact that a motor tug does not consume fuel while standing by or waiting for a job is a big consideration. A tug always has to be ready to answer an emergency call, which means that many tons of coal are consumed without moving the tugs an inch. Further, the motor takes up less space than that occupied by the steam engine and its attendant boilers. But difficulties are encountered in connection with the reversal and speed variation of the internal-combustion engine, and the conditions of the river are such that the engine-room telegraph is constantly in use. The result, says "Quex," will probably be that the Thames tugs will be the first British vessels to adopt the electric drive that is increasing in popularity in America. The Diesel engine will then work steadily on, generating electricity, while on the bridge the skipper will have a switchboard which will permit him to control the propelling electric motors at his will.

Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

GREASE CUPS.

128,441.—F. F. Forshee, 124, Anne Street, and Copeman Development Co., both of Flint, Michigan, U.S.A.—July 24th, 1918.—A grease cup adapted to receive a collapsible grease capsule

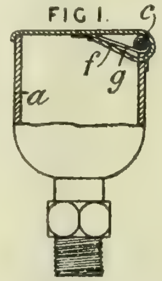
FIG. 6.

a and to be fitted with a piston, is formed with a flared mouth b, and is made from sheet metal by a series of stamping operations. A cap formed with a threaded opening to receive the stem of the piston is made in a similar manner.

LUBRICATORS.

128,497.—H. Mills, 19, Floyer Road, Small Heath, and Partridges Ltd., Northwood Street, St. Paul's Square, both in Birmingham.—Nov. 28th, 1918.—A hinged lid for a lubricator is

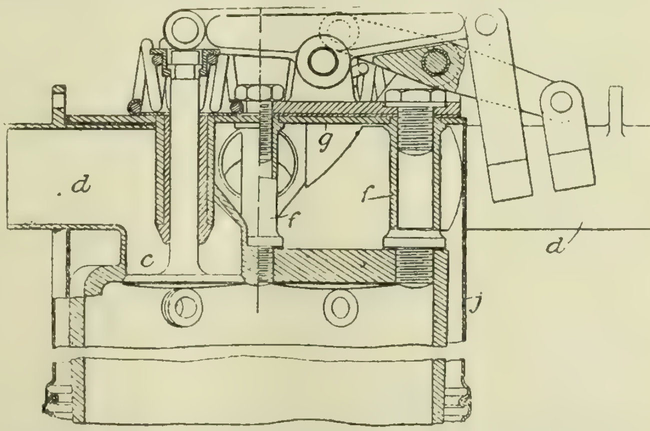
FIG 1.



formed with an integral loop f which contains a coiled spring g surrounding a tongue c formed on the body a. One end of the tongue c is free so that the lid and spring can be placed over it when bent out of its normal position.

INTERNAL-COMBUSTION ENGINES.

128,652.—E. J. J. Salmson, Avenue des Moubineaux, Billancourt, France, and Dudbridge Iron Works, Stroud, Gloucestershire.—

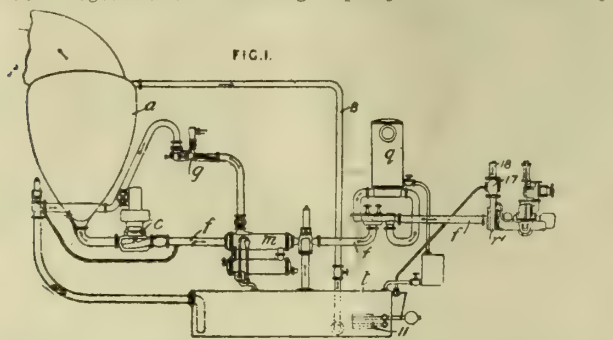


Aug. 24th, 1917.—The cylinder barrel is turned out of the solid with projecting necks c to which are welded pipe elbows d. To these is welded a sheet-metal jacket j with a cover g supported by studs f.

FEED-WATER SYSTEMS.

128,849.—G. and J. Weir, and C. R. Lang, Holm Foundry, Cathcart, Glasgow.—Dec. 20th, 1918.—Relates to feed-water systems of the kind described in Specifications 125,149 and 126,014, and comprising a condenser a, condensate pump c, air-ejector g, surface feed-heater m, feed-tank t, and a feed-pump r1. The invention consists in controlling the rate of discharge of the feed-pump in accordance with the level in the feed-tank t in order to prevent the emptying of the feed-tank and the

consequent access of air to the system. For this purpose, a float 11 is provided in the feed-tank together with linkwork or other means for actuating a throttling-device 17 in the discharge pipe of the pump or for controlling the supply of motive fluid to the motor driving the pump. Where a number of feed-pumps are used together, the centrifugal pumps are controlled by



throttling the discharge, and the direct-acting steam-driven pumps by controlling the motive fluid. Instead of providing a return pipe 8 leading from the feed-tank to the condenser as described in the above mentioned Specifications, the return pipe 8 may be led from the main feed pipe *f* on the discharge side of the secondary feed-heater *q*.

STEAM-GENERATORS.

128,930.—P. H. MOREAU, 86, Avenue Wagram, Paris.—June 24th,

FIG.2.

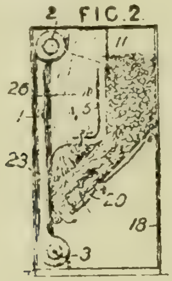
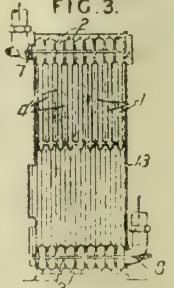


FIG.3.



1919.—Vertical sheet-metal sections are placed side by side so as to form between them narrow vertical flues in front of and above the furnace. The sections and the furnace are enclosed by a sheet-metal casing. The P-shaped stamped metal sections 1 are placed in communication with one another through flanged top and bottom openings 2, 3, bolts 7, 8 passing through the opening securing the sections together. Ridges 5 stamped out from the walls of the projecting parts 26 partially close the lower and outer edges of the narrow flue spaces 4 between the sections. A side wall of the casing 18 is arranged at a distance from the projecting parts of the sections so as to form a fuel magazine 11, from which the fuel falls on to the inclined grate 20 beneath the flues 4. Air is admitted to the furnace through apertures 23 stamped in the walls of the sections.

SECTIONAL BOILERS.

128,946.—H. MOREAU, 30, Rue Drouot, Paris.—June 25th, 1919.—Flat sheet-iron sections 2 with autogenously welded edges and connections at the holes 3, 4 are mounted in the rear compartment of a casing 1 lined with refractory slabs 7, 7^1, 7^2 in the

FIG.2.

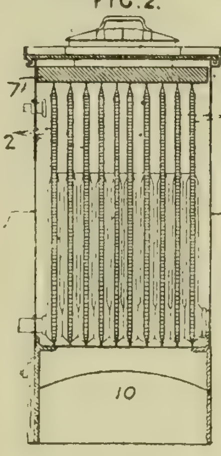
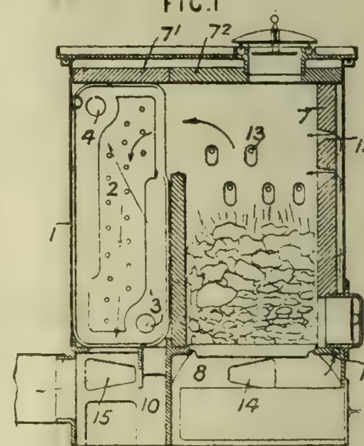


FIG.1



front part of which is the firebox. Air can rise through holes 12 into the space between the casing and the slags and, thus heated, can pass through holes 13 into the fire space above the fuel. The air space can be preserved by ribs on the casing or by packing with broken earthenware. The cast-iron base is divided by a partition into an ash-pit 8 and smoke-box 10, air inlets 14, 15 being provided for each, the control of which may be interconnected.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

THE FUTURE OF GAS.

WITH the advent of electricity—or, rather, when that power had been developed—it was openly stated that gas for any purpose at all was a thing of the past. Instead of dying, however—or even becoming moribund—the gas industry has developed enormously during the past twenty years, and is a very live factor to-day in economical lighting, heating, and power. Anyone who has read the extremely able presidential address of Sir Dugald Clerk, K.B.E., F.R.S., to the Institution of Gas Engineers, will be convinced that those behind the gas industry recognise the competition they have to face, and are ably prepared to meet it.

Sir Dugald Clerk holds that, instead of showing signs of exhaustion in actual fact, the gas industry compares in every respect favourably with its chief rival electricity, and in two out of the three main aspects of its claims on the public patronage shows itself as being infinitely superior.

These three chief uses are stated to be heating, power, and light. As regards the latter, the possession of the incandescent mantle makes gas highly efficient. In the generation and distribution of motive power it is thermally more efficient than electricity, while in the general production of heat for domestic and manufacturing purposes it is overwhelmingly superior to its younger rival.

The most important consideration at the present time is the conservation of coal. Dealing with this point, Sir Dugald Clerk points out that if it were possible to generate gas from the whole coal without the production of coke, at an efficiency of 80 per cent, then the heat of 16 million tons of the 20 millions would be available for distribution. That is to say, dealing with the same total coal at at present carbonised, the gas industry would have a supply for distribution of more than three times the potential heat, light and power requirements of the country. He claimed that the country could absorb this greatly increased supply with great financial and thermal advantage, and he estimated that, under these conditions, the total field open to the effective competition of the gas industry was about 110 million tons of coal.

In order to increase the efficiency of gas utilisation, it was suggested that the construction and operation of all forms of gas-consuming apparatus should be considered. It appeared advisable to provide some establishment, such as a "Gas Institute," devoted solely to studying, testing, and reporting on such apparatus. Such an Institute would be admirably placed, provided it had an efficient and practical staff, for stimulating invention and discovery in gas appliances, and to systematise the collection of the necessary data of the industry, a point which has been a good deal neglected in the past.

OIL CIRCUIT BREAKERS.

By G. E. Gittins, B.Sc. (Lond.) and D. R. Davies.

With the advent of the large power station and increased capacity of generating units, the necessity for careful consideration of the controlling switchgear is being forced upon engineers responsible for the layout and working of such stations. Failure of an oil circuit breaker may result in a serious breakdown, involving heavy penalties where continuity of supply has been guaranteed.

The present article deals with the oil circuit breaker, its functions, and the desirable features which may be looked for in a well-designed piece of apparatus of this class.

An important function of an oil circuit breaker of given current carrying capacity is to open and clear the system when overload or short-circuit conditions occur, and this with the least possible delay and damage to the system controlled.

It should be remembered that the switch has to protect the system, and that any attachment which delays the opening under short-circuit conditions, and until the current has reached a sustained value, is, in general, undesirable, although, from the point of view of the switch short-circuit capacity, this would be an advantage.

The remedy is in all cases to install breakers equal to the worst conditions of their service.

Short-Circuit Capacity.

Various interpretations have been put upon the terms "short-circuit capacity," "rupturing capacity," "breaking capacity" by manufacturers, but the following definition will be found to be the one generally acceptable.

"The rupturing capacity" or "short-circuit capacity" of an oil-circuit breaker may be defined as the maximum K.V.A. the breaker will interrupt, such maximum K.V.A. being the product of the rated working pressure in kilo-volts and the actual current measured in R.M.S. values at the instant of separation of the arc tips, multiplied by 1, 2, or $\sqrt{3}$, according as the system is one-phase, two-phase, or three-phase.

Choice of Breaker.

In choosing a particular breaker, the engineer should have before him full particulars of the system, such as whether the breaker is to be used on a generator or feeder, or transmission line, together with data relative to reactance, either inherent or added, so that he may be able to estimate the maximum possible current which the breaker may have to deal with under short-circuit conditions.

An essential of a high rupturing capacity oil switch is the strength of the cover, the tank, and the attachment of the tank to the cover. During the arcing period the energy expended inside the switch tank disappears in the form of intense heat disintegrating the switch oil, and partly volatising the arcing contacts. The shock to a breaker on a large system is undoubtedly very severe, as a considerable volume of gas is produced in a short interval of time, giving a force applied to the tank, which takes the form of an impulsive blow. This blow or impulse is transmitted hydrostatically through the oil in all directions, with the result that in cases of badly designed mechanical parts the tanks may be permanently deformed or forced away from their supports.

Important Desiderata.

An ideal circuit breaker would completely interrupt the current after the first zero value following contact separation. In practice on large powers this is not realised, due to (1) insufficient separation of the contacts, (2) ionised gas in the arc, (3) volatilisation of the contacts and suspended carbon in the oil which lowers the dielectric strength, (4) insufficient head of oil above the arc.

It would probably be both difficult and dangerous to interrupt an alternating current during any half period, but a high figure for the initial acceleration of contact separation must be aimed at and attained. It is, of course, most important to provide means for preventing the re-establishment of the arc as quickly as possible after the first zero position following the separation of the arc tips. Clearly if this is accomplished less energy is dissipated in the tank with less deterioration of the oil and less temperature rise.

It is a common mistake to assume that switches having a long break have necessarily a high rupturing capacity. A long break is almost useless without having at the same time a large head of oil above the arc. It is better to employ a comparatively short quick break with large head and with large air space, than a long break, small head, and small volume of air.

For successful operation the gas produced by the disintegration of the switch oil must be removed as quickly as possible, since the space surrounding the arc tips is gaseous, in which the gas particles due to the intense heat are completely ionised, forming a conducting path. It is highly probable that during the arcing period the resistance of the path remains constant.

The volume of the gas liberated is directly proportional to the switch energy, and is of the order of 50 cubic centimetres per kilowatt second in the arc measured at normal atmospheric pressure and at 30° Cent. An analysis of the gas produced shows that it is mainly hydrogen and ethylene mixed with small quantities of methane, oxygen, nitrogen, and carbon-dioxide, the oxygen, nitrogen and carbon-dioxide being probably liberated from the particles of air entangled in the switch oil.

The rupture of the arc takes place in a sphere of gas produced by the heat of the arc, and it is useless to assume that the arc has to puncture a layer of oil at each half period. It is of vital importance to adopt measures which will prevent the arc from rising above the surface of the oil, as if this should take place there is a hazard of the arc firing the mixture of oil gases and air contained in the space above the oil level. It is, therefore, extremely important to provide for a large head of oil above the arcing contacts.

The volume of the air chamber should be so designed that the volume of the gas produced by the arc under short-circuit conditions, when mixed with the air contained in the compression space above the oil level, should be far removed from the theoretical condition for maximum explosive effect. The volume of the gas produced should preferably not lie between 10 and 40 per cent of the volume of the mixture. If the mixture should happen to contain

hydrogen and ethylene mixed with atmospheric air in certain proportions, and this mixture fired by the arc rising due to insufficient head, then if the switch is not suitably vented, no cover, however strong, is likely to stand up to the explosive shock. Vent pipes, where provided, should be free from bends, and be of ample cross sectional area.

Switches are now being built with the tops fitted with check valves, which close when the pressure in the air chamber rises above atmosphere.

The following investigation shows the possible rise of the pressure which may occur in an oil switch of given air space above the oil under short-circuit conditions.

We know that if a given gas has a volume V, and a pressure p, that

$pV = MRT$,
where M is the mass of the gas,
R is the gas constant,
and T the absolute temperature.

Now, in applying this law to determine the final pressure produced in an oil switch during short-circuit conditions, the volume is the volume of the air chamber in cubic centimetres above the oil level, and, in order to simplify the problem, we assume the chamber to be gas tight.

Initially just before short-circuit we have a pressure of p_0 Kg. per sq. cm., at a temperature of T_0, and just after the switch has opened a pressure of $(p_0 + dp)$ Kg. per sq. cm. at T_1. C°. So that initially we have $p_0V = MRT_0$,

and finally
$$(p_0 + dp)V = (dM + M)RT_1$$
or
$$Vdp = MR(T_1 - T_0) + RT_1\,dM.$$
But
$$dM = KA,$$
where A is the arc energy in KW. seconds and K is a constant;

also
$$MR = \frac{p_0V}{T_0}$$

Hence
$$dp = p_0\left[\frac{T_1}{T_0} - 1\right] + \frac{KART_1}{V}$$

Example.—An oil circuit breaker has an air chamber of 22,800 cub. cms. for all three phases. Assuming that the breaking capacity is 48,000 KVA, determine the rise in pressure during short-circuit conditions.

If we take the arc power factor as ·07, and the switching time as ·08 second, then

$A = 48000 \times {\cdot}07 \times {\cdot}08$
$= 269$ KW. seconds,
and $T_0 = 303$ °C
$T_1 = 673$ °C
$K = 13{\cdot}7 \times 10^{-3}$ grms. per KW. second.
$R = 11{\cdot}7$ cm. Kg.

Hence
$$dp = p_0\left[\frac{673}{303} - 1\right] + \frac{13{\cdot}7 \times 10^{-3} \times 269 \times 11{\cdot}7 \times 673}{22800}$$
$$= 1{\cdot}22p_0 + 1{\cdot}27.$$
If $P^0 = 1{\cdot}02$ Kg. per sq. cm.
then $dp = 2{\cdot}51$ Kg. per sq. cm.,
or $2{\cdot}51 \times 14{\cdot}22 = 35{\cdot}8$ lbs. per sq. inch.

The importance of the oil level above the arcing tips has previously been referred to, and it should be noted that the chimney effect is lessened by increasing the depth of the contacts below the oil surface, and is very dangerous with small depths. At each depth there is a certain load at which the gas begins to ignite and a higher load at which the arc persists.

It is preferable that the volume of the mixing chamber should have either such a large volume that the chimney effect cannot carry up more than one-half of one per cent of gas or else such a small volume that it must carry up more than 40 per cent.

Speed of Break of Oil Switch.

It has been customary in the past to specify the average velocity over the switch travel. This is not important. What really matters is the velocity of the moving parts at the instant the arc tips separate, and the time that it takes the switch to travel to half-open position. A high initial velocity is extremely desirable, and in the case of heavy current switches having considerable inertia of the moving parts, this can only be obtained by the use of powerful throw-off springs combined with brushes of the wound pattern, and arranging for the pitch of the poles of the same phase to be considerable. This last requirement is frequently limited by other considerations.

Failure to interrupt a short circuit by an oil switch simply means that the breaker space is too limited to deal with the current volume produced, that the mechanical parts of the switch are not sufficiently strong for the service, and that the velocity of the moving elements is too small to obtain a length of travel such as to prevent the arc from persisting indefinitely as the current crosses the zero line.

Value of Short-Circuit Current.

The wave of short-circuit current is limited by the reactance in the machine and reactance external to the machine, such external reactance taking the form of cables, transformers, reactance coils and the like.

It is desirable that the term "reactance," as applied to a generator, should be very clearly understood, and the following definition of generator reactance will be used in what follows:—

Generator reactance is the value expressed as the percentage ratio of full-load current to the short-circuit current, full-load voltage and no external impedance being assumed.

The internal reactance of the machine is of a transient character, and usually does not reach its sustained value for a considerable number of periods. The external reactance may be regarded as being constant over the switching period, whereas the generator reactance will have a definite value at a definite instant of time after the short circuit occurs.

The wave of total current may be divided into two components, (1) a D.C. component and (2) an A.C. component. The D.C. component usually disappears with ·4 to ·5 seconds, and the A.C. component decreases to a sustained value within two to three seconds. The initial rush of the current under short circuit conditions may rise to $2\sqrt{2}$ times the value obtained from a consideration of the internal reactance of the machine, this being due to dissymmetry or "doubling effect," but this is not of importance from the point of view of switch short circuit capacity, since the switch short circuit K.V.A. is determined by the R.M.S. value of the current during the arcing period.

The principal factors governing the value of the short-circuit current are—(1) The total reactance and transient characteristics of the synchronous machines connected up to the system, such total reactance consisting of that inherent to the generators, choking coils, transformers and capacity effects connected. (2) Whether the short-circuit is symmetric or whether the wave of current is off set, the latter value being determined by the particular point on the pressure wave at which the short circuit is established. (3) Whether the alternators are, or are not, fitted with automatic voltage regulators; if fitted, the value of the sustained short-circuit current would be of the order of three times normal, whereas if not fitted the sustained value would probably not exceed twice normal.

In the absence of exact information it is usual to assume some reasonable value for the inherent reactance of the generators, *e.g.*, assuming eight per cent reactance, that is $12\frac{1}{2}$ times full-load current at the first instant of short circuit, rising to 16 per cent reactance by the time that the arc tips separate, giving, therefore, $6\frac{1}{4}$ times full-load current to be dealt with by the breaker.

The following examples will show the methods of calculation in a number of typical cases:—

General Characteristics of Switch Oil.

Most manufacturers use the same quality of oil for their oil switches as they do in their transformers, the necessary general characteristics being the same. The oil in the switch tank is subjected to much more severe conditions than that in a tank of a transformer, as the heating is localised for the oil switch, and, moreover, when the switch opens and breaks the circuit an arc plays through the oil and disintegrates it into gas and carbon particles. The carbon particles float about in the oil and lower its dielectric strength, but if the oil be filtered free from this suspended carbon matter, it will be found that the dielectric strength has returned to its former value.

The essentials of a good switch oil are—(1) high flash point, (2) low viscosity, (3) high dielectric strength, (4) not easily liable to sludge, (5) small percentage loss by evaporation at temperatures not exceeding 80 deg. or 90 deg. Cen., (6) large thermal capacity, *i.e.*, with a given mass of oil a high specific heat.

Sludging or thickening of the oil due to alteration in its chemical constitution is not so important a consideration for switch oil as it is for transformer oil, but is is desirable that that which is used in the switch shall be as free as possible from this property. The sludging is due to the oxidation of the unsaturated hydrocarbons of the $C_n H_{2n}$ series, accelerated by the presence of the copper and metal parts in the oil. Sludging, however, is improbable with a good quality of oil at the temperature of oil switch operations.

The following table gives data of a good sample of switch oil:—

Density at 19 deg. Cen. = ·86 gram. per cc.
Specific heat. ·44 cal. per gram. per Cen. deg.
Flash point = 167 deg Cen.
Loss on heating at 100 deg. Cen. for 8 hours 1·87 per cent.
Boiling point 321 deg. Cen.
Latent heat of vaporisation 328 calories per gram.

Viscosity.

Temperature	8° Cen.	20° Cen.	30° Cen. and	40° Cen.
Time	290	152	100	75
		measured in seconds.		
Viscosity...	60	31	21	17

Measured on the rape oil standard of 100 at 15·5° Cen.

An examination of the curve obtained by plotting viscosity against temperature shows that it is approximately an equilateral hyperbola between the limits of temperature taken and may be represented by:—

Viscosity × temperature = 620.

Dielectric Strength.

In obtaining the dielectric strength of switch oil it should be definitely stated whether needle or sphere electrodes are used, whether the electrodes are vertical or horizontal, and what head of oil is to be used during the experiment. It is, of course, important that the oil should be free from traces of water vapour, as the presence of water vapour lowers the dielectric strength enormously. An average value of the dielectric strength obtained by using $\frac{1}{2}$ in. spheres and an oil film ·01 in. thick is 200/300 V. per mil., the spheres being not less than 3 in. below the oil surface.

Products of Decomposition.

As previously stated, when an arc burns beneath the oil, the oil is disintegrated, and the products of disintegration do not vary materially over a wide range of switch oils and current volumes employed in the decomposition. Broadly speaking, the mixed gases consist of 80 per cent hydrogen and 20 per cent ethylene by volume, the volumes being measured at 20 deg. Cen. and 760 millimetres pressure. There will also be frequently found traces of methane, carbon dioxide, carbon monoxide, oxygen and nitrogen, the traces of carbon dioxide, nitrogen and oxygen probably being present due to air particles being entangled in the switch oil. For continuous

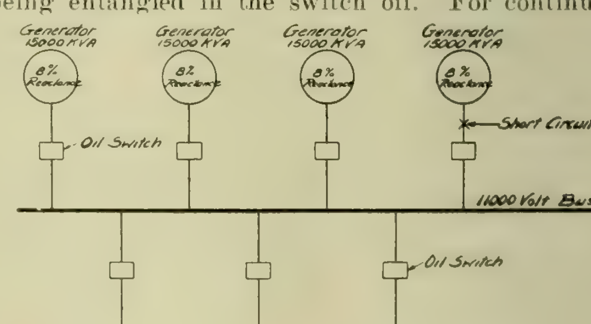


Figure 1

service, the temperature of the oil in the neighbourhood of the contacts should not be allowed to exceed 80 deg. Cen., that is, a possible temperature rise of 40 deg. Cen. In no case should the switch oil be allowed to rise above the temperature of 90 deg. Cen. In general the dielectric strength of the oil is found to increase as the temperature is raised, but figures should be received with caution, as the obtained values of the dielectric strength (showing an increase) may be due to a drying out of the oil itself. The oil in the switch tanks should be systematically inspected, and always replaced by fresh oil following the interruption of a short-circuit. The loss by evaporation may be made good from time to time by the addition of fresh oil.

EXAMPLE 1.—Four generators, each of 15,000 K.V.A. capacity, and of internal reactance of 8 per cent, are in parallel on the same bus-bars. A fault develops on the generator side of one of the oil switches. Find the rating of the breaker to deal with the fault. In Fig. 1, since each generator has an internal reactance of 8 per cent on 15,000 K.V.A., then for three generators in parallel the reactance will be $\frac{8}{3}$ per cent, and therefore the breaker should have a short-circuit capacity of

$$\frac{15000 \times 300}{2 \times 8}$$
$$= 280,000 \text{ K.V.A.},$$

this in on the assumption that each generator reactance has reached a value of 16 per cent by the time the arc tips part.

EXAMPLE 2.—Four generators in parallel with added external reactance, as in Fig. 2. Assume each generator to be of 15,000 K.B.A. capacity to have an inherent reactance of 10 per cent, with an added external reactance of 5 per cent. Required to find the capacity of the feeder breaker to open a fault at F. Since the transient reactance of one generator is 10 per cent, this will probably have risen to 20 per

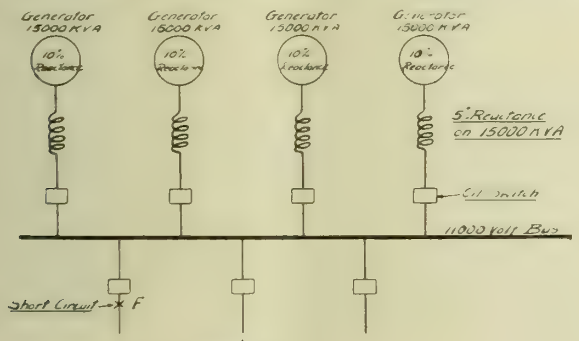


Figure 2

cent by the time the breaker arc tips separate, hence the total reactance in circuit with one generator will be 25 per cent. For four generators in parallel this becomes $\frac{25}{4} = 6\frac{1}{4}$ per cent, based on 15,000 K.V.A., and therefore the breaker rating should be

$$\frac{15000 \times 400}{25}$$
$$= 240,000 \text{ K.V.A.}$$

EXAMPLE 3.—Referring to Fig. 3, assume generators of 30,000 K.V.A. each and of 12 per cent reactance feeding through transformers of 30,000 K.V.A. and 8 per cent reactance on to a bus. With a feeder fault, as shown, find the breaker rating. Since the transient reactance of a generator is 12 per cent, we may assume that it will have risen to 24 per cent by the time the breaker arc tips separate.

For one generator the total reactance in circuit will be 24 per cent plus 8 per cent for the transformer, *i.e.*, 32 per cent based upon 30,000 K.V.A. Four such reactances in parallel give an effective reactance of $\frac{32}{4} = 8$ per cent.

To this again we must add the feeder reactance. This is 3 per cent based on 15,000 K.V.A., or

$$\frac{30000}{15000} \times 3 = 6 \text{ per cent.}$$

based on 30,000 K.V.A., giving a total of 14 per cent. The K.V.A. fed into the fault will be, therefore,

$$\frac{30000 \times 100}{14} = 214000 \text{ K V.A.}$$

EXAMPLE 4.—Four 30,000 K.V.A., 11,000 volt, three-phase 50 period generators feed into a ring bus

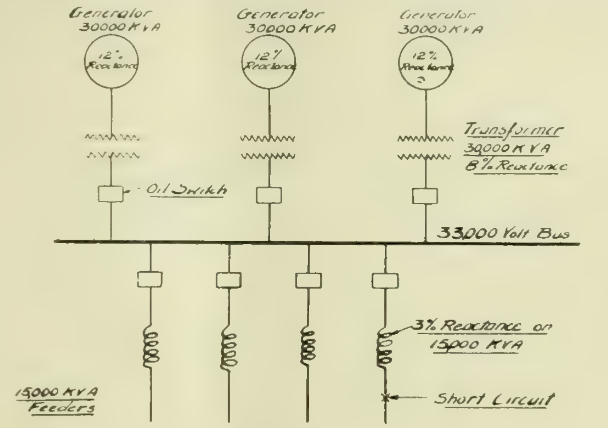


Figure 3

sectioned by reactances as shown in Fig. 4. Find the rating of the feeder breaker to deal with a fault at F. Each bus reactance is assumed to have a value of 10 per cent based on the normal current and voltage of one machine. It is further assumed that

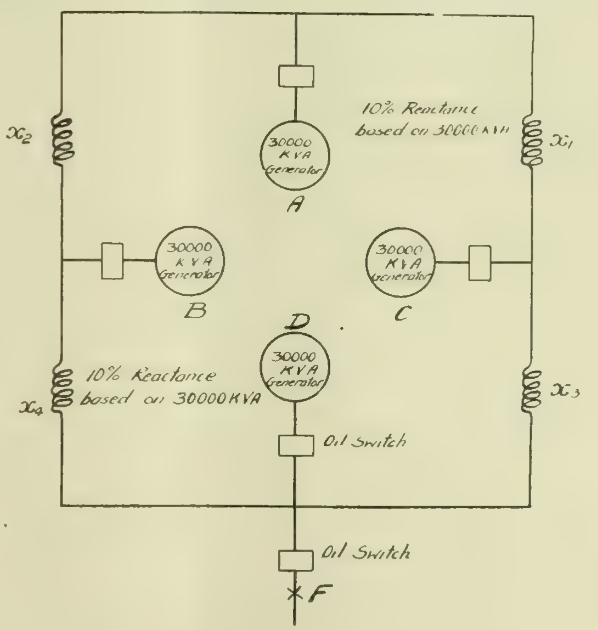


Fig. 4

the generators are fitted with automatic voltage regulators, and that the maximum obtainable excitation is three times the excitation for normal open circuit volts. The sustained short-circuit current with maximum excitation is taken as twice normal, that is, the synchronous impedance is 50 per cent.

The value of each bus reactance corrected for maximum excitation is $\frac{10}{3} = 3\frac{1}{3}$ per cent.

For generator A alone X = 50 per cent, and for the reactances x_1 and x_2, we have two reactances of $3\frac{1}{3}$ per cent in parallel; since $x_1 = x_2 = 3\frac{1}{3}$ per cent on 30,000 K.V.A.

For A plus x_1 and x_2.

$$X_1 = 50 + 1{\cdot}66.$$
$$= 51{\cdot}66 \text{ per cent.}$$

Including generators B and C respectively and calling the total X_2 we have

$$\frac{1}{X_2} = \frac{1}{51{\cdot}66} + \frac{2}{50}$$
$$= {\cdot}0194 + {\cdot}04$$
$$= {\cdot}0594,$$

and $$= X_2 = 16{\cdot}85 \text{ per cent.}$$

Each of the reactances x_3 and x_4 has the value $3{\cdot}33 + 1{\cdot}66 = 5$ per cent say. This is based on 45,000 K.V.A. so that

$$X_3 = 16{\cdot}85 + 2{\cdot}5$$
$$= 19{\cdot}35 \text{ per cent.}$$

Including the last generator at D, we have

$$\frac{1}{X_4} = \frac{1}{19\ 35} + \frac{1}{50}$$
$$= {\cdot}0517 + {\cdot}02$$
$$= {\cdot}0717,$$

and $$X_4 = 14 \text{ per cent.}$$

Hence K.V.A. fed into fault

$$= \frac{30000 \times 100}{14}$$
$$= 214000 \text{ K.V.A.}$$

The current divides among the parallel paths inversely as the impedances. Thus:—

Generator A.—$1{\cdot}66 + 5 = 6{\cdot}66$ per cent. Add 50 per cent for the generator and we get $56{\cdot}66$ per cent total.

$$\text{Hence Curent} = \frac{100 \times \text{normal}}{56{\cdot}66}$$
$$= 1{\cdot}77 \times \text{normal.}$$

Genrators B and C.—

$$5 + 50 = 55 \text{ per cent,}$$

and $$\text{Curent} = \frac{100 \times \text{normal}}{55}$$
$$= 1{\cdot}82 \times \text{n rmal.}$$

Generator D.—

$$\text{Current} = \frac{100 \times \text{normal}}{50}$$
$$= 2 \times \text{normal.}$$

Reactance	Current × normal.	Per cent Volts drop.
$x_1 - e$ ...	0·885 ...	8·85
$x_3 - x_1$ ...	2·7 ...	27

Voltage at terminals of Generators:

For A $$\frac{(8{\cdot}85 + 27) \times 11000}{100}$$
$$= 3914 \text{ volts.}$$

For B – C $$\frac{27 \times 11060}{100}$$
$$2970 \text{ volts.}$$

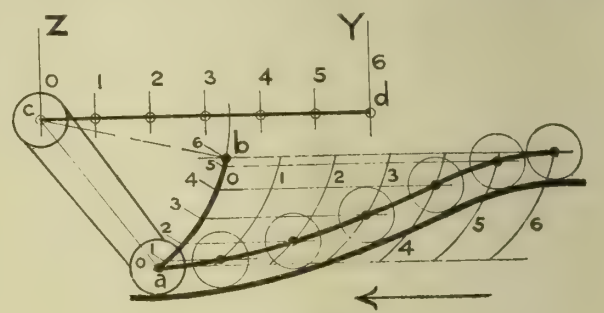
For D = O.

CAMS.

By W. E. Bennison, A.M.I.M.E.

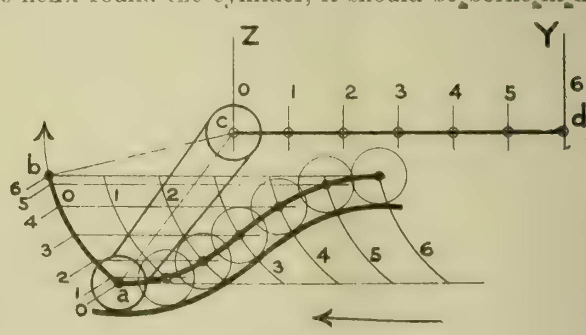
(*Continued from page 266.*)

XIII. Harmonic motion: roller contact; angular movement.—Here again the roller is carried by the free end of a lever, but the position of the lever is pretty well inclined to the axis. Two examples are given of this case, viz., Figs. 45 and 46. In Fig. 45 the roller lifts towards the cam, and in Fig. 46 the roller lifts away from the cam. Except for the levers being opposite hand to each other, all conditions are exactly alike in the two figures. *c* is the lever fulcrum, *a b* the follower path, and the striaght line *c d* is equal to the cam angle



Cams.—Fig. 45.

There is no need to describe the construction, which is exactly the same as the last example except for the spacing of the points in the follower path. The arc *a b* must be divided harmonically. Fig. 31 gives the correct displacement curve to use. The rest of the construction is the same as in the last example, the points on *a b* being projected into their respective follower paths by parallel lines. The difference in shape between the two curves caused by the difference in position of the levers is very distinct in this example. The curves obtained are, of course, the developments of the respective helices. For this type of cam, when wrapping the helix round the cylinder, it should be borne in mind

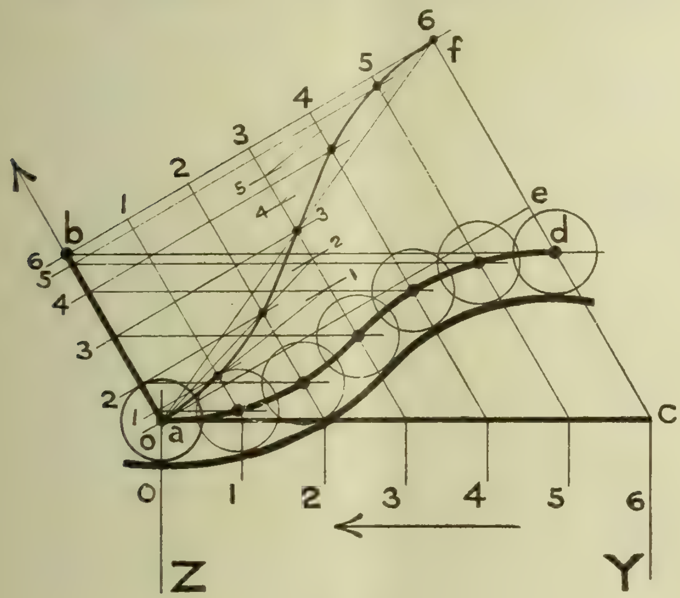


Cams.—Fig. 46.

that the line *c d* is wrapped round to form the arc of a circle whose plane is at right angles to the axis.

XIV. Constant acceleration and retardation velocity: roller contact; rectilinear motion, inclined to axis. (See Fig. 47.)—The straight line *a b* is the follower path, and the horizontal line *a c* represents the circular arc subtended by the cam angle. The construction is very similar to the one given for Case XI. (Fig. 43), only the follower path is not perpendicular to *a c*. The various follower path positions form a series of equidistant

straight lines all parallel to $a\ b$: these are numbered 0 to 6, the final one being $c\ d$. The straight line $a\ b$ is divided to give constant acceleration and retardation to the follower. For this the displacement curve given in Fig. 38 can be used, or if preferred, it can be drawn directly on the lines $a\ b$ as is shown in Fig. 47. Through the points a and b perpendicular lines are drawn, meeting $c\ d$ produced in the points e and f. The rectangle $a\ b\ e\ f$ can now be used as the displacement curve diagram and that curve plotted within it. All the follower path positions are produced until they meet the line $b\ f$: as they are equally spaced they may be used for the ordinates of the curve. The curve consists of two parabolas constructed exactly as in Fig. 38. $a\ b$ and $f\ e$ are the axis and a and f the vertices of these parabolas, which meet at the centre point of the centre ordinate. The centre ordinate is divided into six equal parts, points 1 and 2 being joined to vertex a, and 4 and 5 to vertex f. The intersections of these lines with their respective



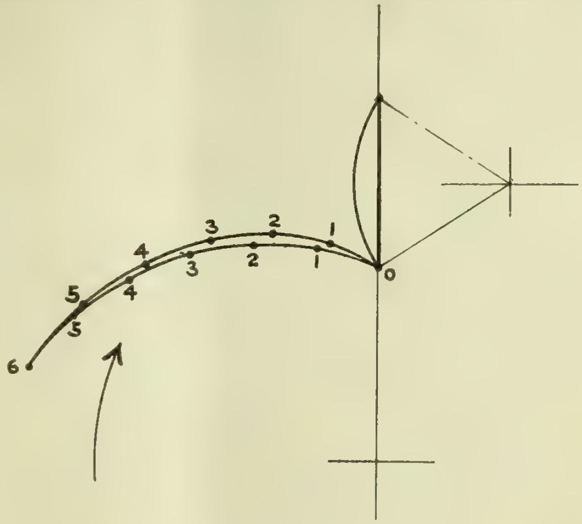
Cams.—Fig. 47.

ordinates give points on the displacement curve. These points are projected into the line $a\ b$, which is now correctly spaced. The rest of the construction is exactly after the manner described for all other helical cams, the points of $a\ b$ being projected into the follower path position of the same number to give the roller centres.

In the preceding examples it will have been noted that the greater the number of parts into which the cam angle is divided the greater will be the accuracy of the curve. In the figures, six divisions only have been taken for the sake of complicating the construction as little as possible; if great accuracy is required many more positions for the follower will have to be employed.

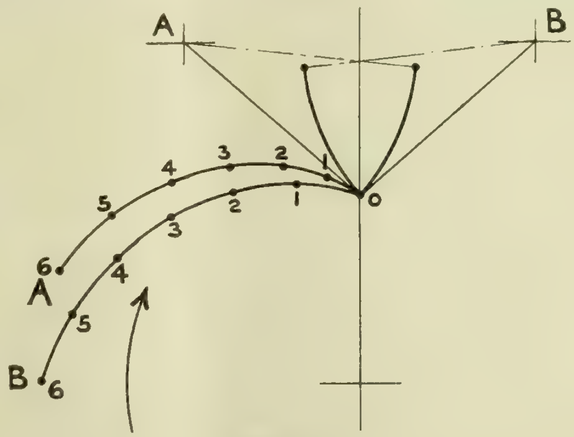
It will also have been observed that the smaller the diameter of the roller the nearer will the actual cam form approach to the true one.

It is not necessary for the designer to follow out religiously all the construction shown in the diagrams: he may leave out just as much as he likes, or take as many short cuts as he pleases, as long as he obtains the desired result. It may perhaps not be out of place to remark, however, that the writer has come across many cases of error arising through too much being taken for granted. A case in point is the angularity of a lever when actuated by a cam. Supposing the lever to be long in comparison to its stroke, the arc through which the axis of the follower moves will approximate to a straight line motion. In many cases, however, this is not allowable, and the construction must be religiously adhered to. Fig. 48 shows the two conditions com-



Cams.—Fig. 48.

bined in one figure to illustrate the difference in the curves. Uniform motion has been taken, and all conditions are the same, except that in one case the follower moves along a straight line, and in the other along an arc. The upper curve is the one for straight-line motion and the lower the one for angular motion. It seems almost incredible that these two cases should be mixed up, yet the writer has known that happen many times. The distance bewteen any pair of points, say, 22, 33, or 44, shows how much the curve would be out in this particular case. Fig. 49 shows another interesting com-

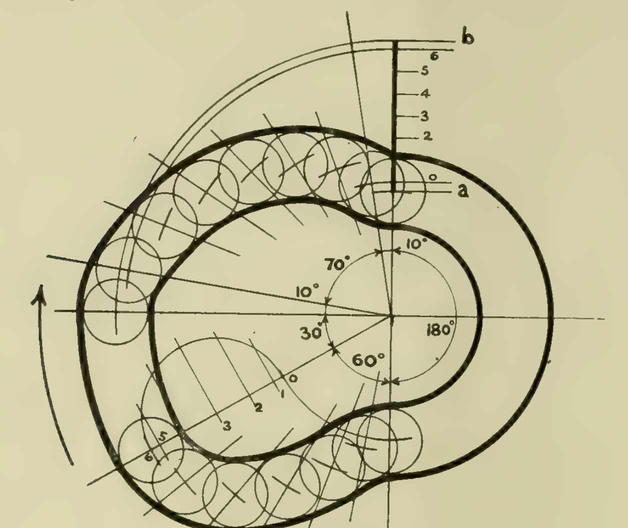


Cams.—Fig. 49.

parison, and illustrates how the shape of the cam is affected by the angularity and position of the lever. Here are two levers exactly similar to each other in every respect, except that they are opposite hand, that is, are placed symmetrical to each other about the axis of the cam: the two follower paths meet at

the point O. The left-hand roller moves in the direction of the cam's motion, and the right-hand one in the contrary direction. The upper curve A is for the left-hand lever, and the lower one B for the right-hand lever.

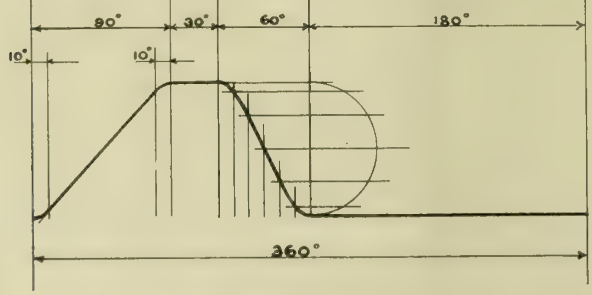
All the foregoing examples have been simple ones, intended to show how to construct the curve for any type of motion. Usually, however, a cam moves through 360 degs. for one cycle of operations. During that revolution it may be necessary for the



CAMS.—FIG. 50.

follower to have one, two, or several reciprocations, and perhaps to be at rest for a portion of the time. A complete cam is therefore usually built of several curves joined together. It is proposed to give a few more complicated examples showing complete cams.

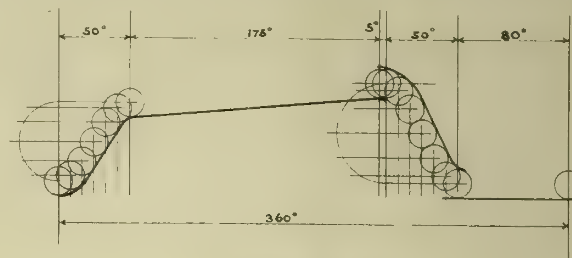
Fig. 50.—The follower makes one complete reciprocation for one revolution of the cam. It is desired that the follower shall have uniform motion during its forward stroke, which takes 90 deg. of time. As it is not practicable to start up a load into full velocity at once, the follower path is made slightly longer



CAMS. FIG. 51

than necessary, and a small portion at either end allotted for starting up and slowing down. Thus, from *a* to *o* the velocity increases from nothing to maximum, and may be made, say, harmonic. Ten degrees are allowed for this. From *o* to 6, taking 70 deg., the velocity is uniform. From 6 to *b*, 10 deg., the curve is rounded off to slow down the velocity to nothing again. At the outward end of the stroke the follower is at rest for 30 deg., and the cam curve is concentric. The return stroke occupies 60 deg., and the motion is harmonic. For the remaining 180 deg. the follower is at rest in its inward position. The displacement curve is shown by Fig. 51, and well illustrates the velocity.

Fig. 52 shows a cam adapted for reciprocating a slide in a direction parallel to the axis. It is therefore a helical one. The type is one that is largely used for advancing the tool in an automatic turning



CAMS. FIG. 52.

machine. For the first 50 deg. the tool has to get up to the work as quickly as possible, and the motion is made harmonic. Once the cut has commenced the advance is very slow and the velocity uniform; 175 deg. are allowed for this. There is a rest of 5 deg. at the end of the stroke, and the return is made in 50 deg., with harmonic motion. During the remaining 80 deg. there is a rest to allow of other operations.

(*To be continued.*)

CONDENSER TUBE CORROSION.—The Corrosion Research Committee of the Institute of Metals invite support of the important research work that they are now carrying out with the object of preventing corrosion generally, and, in particular, that of condenser tubes—a matter closely affecting the regular and economical running of all steamships, as well as their safety. This research work has been in progress for ten years and has been financed firstly by the Institute of Metals alone, and later by the Institute in conjunction with makers of tubes, makers of condensers, and the Government Department of Scientific and Industrial Research. In communicating with the Corrosion Research Committee in regard to their contribution for 1919-20, the Department drew attention to the fact that users of tubes and condensers do not contribute to the cost of the research. "The Advisory Council," it was stated, are of decided opinion that, since this research is of great interest to the users of tubes and condensers, efforts should be made to secure aid for the continuance of the research from the users, as well as from the makers, of tubes and condensers. In accordance with their view that contributions to the cost of the research should be sought from the users, the Advisory Council direct me to state that they will be prepared to recommend for the year ending 30th September, 1920, a further grant-in-aid if satisfactory contributions are obtained by the Institute from the users of tubes and condensers towards the cost of the research. It will be recalled that this decision was foreshadowed in additional condition (4) attached to the grant made for 1918-19." Users of tubes and condensers, including shipbuilders and shipowners, also the insurers of ships, are quite as much concerned with the matter as are those who are already contributing. We are advised that for every £1 contributed by the users the Government will also contribute a like amount. It should be pointed out that the makers are contributing nearly £1,000 per annum, and it is hoped that at least this amount will be forthcoming from the users.

ELECTRIC FURNACES AND WELDING MACHINES.

Messrs. Buckley, Saunders and Co. Ltd. (E. A. Chantler) have secured the agencies for South America for the Wild-Barfield Electric Furnaces, and also for the Argentine for the A.I. Manufacturing Co.'s Electric Welding Machines. Demonstration plants are already erected and working at the works in Buenos Ayres, and can be inspected by applying at the offices, 314, Bme. Mitre. A demonstration Wild-Barfield Electric Furnace will also be in operation shortly in Rio de Janeiro.

THE FOUNDATIONS OF INDUSTRY.

From a Special Correspondent.

The aftermath of a war which has convulsed the whole world must necessarily be a large indebtedness on the part of the belligerent nations, and an unrest which may require a generation to compose. Great Britain, notwithstanding her £8,000,000,000 of debt, is probably in a sounder position than any of her allies except America and Japan. It would be sheer folly, however, on that account, to ignore the critical nature of the industrial and international situation. Too many of our people to-day are content to live from hand to mouth without thought of the morrow. They plunge into the wildest extravagance with utter disregard for the necessity for economy in all directions. It will be a long while before we can feel sure of steering a safe course amid the wreckage left by the war. It is not enough with the blessed word "reconstruction" upon our lips to embark recklessly in this or that direction upon gigantic schemes without counting the cost. Our business, surely, should be coldly and calmly to estimate what assets are left to us, and how best we can use our great natural resources to recover the lost ground. It involves consideration of our relations with other countries and the problem of international finance. But these questions are beyond my purview, and I propose to deal only with certain economic and industrial problems that immediately confront us.

Working together for the Common Ends.

We all profess to have the interest of the nation at heart, and perhaps we are beginning to learn that the interest of one nation is bound up with that of every other nation. In any case, whatever view we may hold about the industrial state and the future organisation of industry, this much is certain: that all classes of the community must work together for the common ends, that the idler must be eliminated, and that every one must contribute of his best if we are to weather the storm. We shall need to utilise to the full every bit of scientific knowledge we possess, and to call to our aid the energy of every man and women who has brains and strength. During the war and since the war there have been some purblind people who, without taking into account the origins of wealth, are quite content that we should go on spending without producing. Many millions of money have been wasted because we have failed to give sufficient thought to the subject of economical production, and my object is, if possible, to secure the assent of all impartial minds to two or three simple propositions. But before doing so let us ask ourselves what are the foundations of our industry and the natural resources from which we draw so much of our wealth.

Coal: The Foundation of Industry.

Prior to 1750, from which year we date the first successful smelting of iron with coal, Britain was chiefly an agricultural country. Since that time there has been a very remarkable industrial development. George Stephenson said that "the strength of Britain lies in her iron and coal beds." Any country that has iron and coal has natural wealth. The country that most successfully utilises its resources in iron and coal is the country that will lead in the world struggle for industrial supremacy. At the very foundation of industrial progress is coal, representing crystallised energy. The three countries that have great natural resources in coal are the United States, Britain and Germany. Other countries, like China and Russia, have enormous coal supplies, but for the most part, the natural wealth they contain lies dormant. With regard to both coal and iron, America has outstripped Britain and Germany; yet in 1885 Britain produced as much pig iron as America and Germany put together. Previous to the smelting of iron with coal, Britain had a population of 7,000,000. In 1862 it had a population of 23,000,000, and produced 3,900,000 tons of pig iron. That is to say, more than all the rest of the world put together. In 1875 we produced nearly half of the coal. In 1885 the British output had risen to 160,000,000 tons, and that of the United States to about 100,000,000. In ten years America was practically level with this country, while Germany was producing over 100,000,000 tons. In 1906 the United States produced 350,000,000 tons as against our 236,000,000. Germany came next with 171,000,000 tons. In 1911 the figures for the three countries were as follows:—

	Tons.
United States	443,000,000
Great Britain	272,000,000
Germany	231,000,000

The United States started later than Great Britain, but she has had some special advantages in that her coal is easier to win, because it is generally nearer the surface and the seams are thicker. She uses far more mechanical power to win her coal, in relation to the manual labour employed, than is used in this country.

When we ask why these three countries have grown so rapidly in prosperity and dominated the rest of the industrial world, the answer is that they are coal-producing countries and that they have utilised their own great natural resources. The coal reserves of the three countries are estimated as follows:—

	Tons
United States	4,000,000,000,000
The German Empire	415,000,000,000
United Kingdom	186,000,000,000

To-day in the case of Germany we must deduct the coal fields that have been taken away from her either temporarily or in perpetuity. The Peace Treaty has reduced her reserves of coal by about one-third.

The Future of the United Kingdom.

It is, however, with the United Kingdom that we are especially concerned.

What is to be the future of this country? Our coal reserves are clearly not inexhaustible. How can we best utilise what we have left, remembering at the same time that the figures given are not an accurate measure of the coal that can be economically produced, by which is meant coal that is not more than 4,000 feet from the surface of the earth. It has been estimated that at the present rate of consumption, our coal supplies will hold out for another 500 years or so. But, as Lord Moulton has said, "the tendency is for consumption to increase every year, so that to give our coal fields only another 200 years lease of economic life would be safer. It is not enough to have coal, it must be available. If we cannot mine coal economically enough to compete with other countries we shall fall behind in the

industrial race." To quote Lord Moulton again: "our future prosperity to a very large extent depends upon the permanence of this prime industrial asset." We may take it for granted that the population of this country will increase, that new industries will be created, and that the use of mechanical power in industry will grow even more rapidly than the population. We shall, therefore, continue to use our coal in even larger quantities, but that does not alter—it only emphasises—the fact that it must be used as economically as possible. No cheaper known source of energy is available in this country, and until one is discovered, if ever, we have no alternative.

We could of course continue to consume our reserves of coal under the wasteful conditions that now prevail, and leave posterity to take care of itself. No sane person would recommend such a course. If we are reckless and wasteful in our consumption of coal, we are mortgaging the future of our country. After all, we have a duty to coming generations, and our duty is to save in coal consumption wherever possible by eliminating waste in the pit and at the pithead, and by creating the energy required for our industries, whether in the form of light, heat, or power, in the most scientific and economical fashion.

DIRECT CURRENT COMPARED WITH THREE-PHASE CURRENT FOR DRIVING STEELWORKS PLANT.*

BY C. A. ABLETT, M.INST.C.E. (LONDON).

MANY steelworks and rolling-mills have adopted three-phase alternating-current electrical plant, whilst many have adopted direct-current electrical plant, so there is obviously a difference of opinion regarding the relative merits of three-phase and direct current. There is justification, therefore, for a general consideration of the advantages and disadvantages of the two systems.

The principal advantage of a three-phase system is that it enables power to be transmitted cheaply over long distances at high voltages, and this system is therefore almost universally adopted by Power Supply Authorities. It has, however, the disadvantage that three-phase motors are not capable of speed variation without considerable loss of power, unless they are of a complicated and costly type, and therefore not well suited to many steelworks purposes.

Direct current, on the other hand, does not lend itself to cheap transmission of power over long distances, but as in most iron and steel works distances are relatively small, this point is not usually one of any great importance. Direct-current motors are naturally capable of speed variation over a wide range without loss of power, and this and other natural characteristics of direct-current motors render them very suitable for many steelworks purposes.

The method of applying electrical power to the various plant in steelworks may be considered in detail as follows :—

ROLLING MILLS.

(*a*) *Merchant and Bar Mills.*—Most of the merchant mills and bar mills in the British Isles roll a large number of different sections, of which the heavier should be rolled at low speeds and the lighter at high speeds. To get the best results and output from the mills, each section should be rolled at its own particular speed. If such a mill be driven by a direct-current motor, the speed can easily be regulated through a very wide range by a shunt regulator in the motor field without entailing any loss of power, and, as the speed of the motor is reduced, the turning moment increases, so that the maximum turning moment is available where it is required for rolling the heavy sections at slow speeds.

* Abstract of paper read before the Iron and Steel Institute at the Annual Meeting, May 6th and 7th.

The direct-current motor possesses a further advantage: its speed remains at about the basis speed corresponding with the setting of the shunt regulator, so that the mill does not run up to high speeds when the bar is out of the rolls.

As an example may be quoted a 400 horse-power motor which was installed to drive an 11-inch merchant mill which could be so regulated that the mill would run at any speed between 60 r.p.m. and 250 r.p.m. Supposing this motor were set to drive a mill at a speed of 60 r.p.m., it would not, if there were no bar in the rolls, run at a higher speed than 66 r.p.m. Closer speed regulation than this could be obtained, which would mean a better tonnage from the mill, but a greater variation of the power of the motor. If an ordinary three-phase motor were employed, the speed could only be reduced below the full speed by inserting resistances in the rotor circuit, which resistances would cause waste of power nearly proportional to the reduction in speed of the motor.

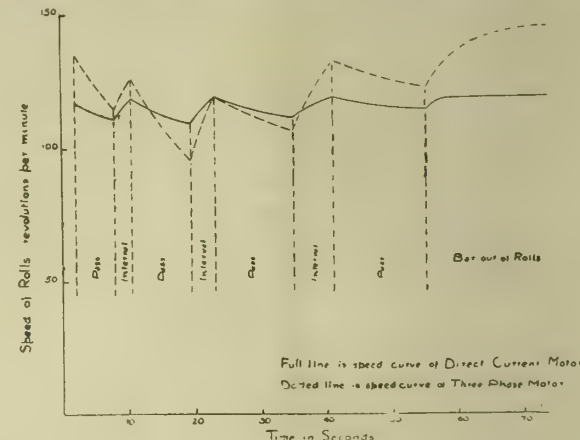


FIG 1.

The three-phase motor cannot give any increased turning moment at the low speeds, but on the contrary tends to lose its overload capacity as the speed is reduced, so that to obtain large turning moments at reduced speed, a large and more expensive motor must be installed. When driving a mill at reduced speed, the three-phase motor tends to run up to full speed as soon as the bar leaves the rolls, and also tends to fall greatly in speed while rolling a heavy section, so that the speed varies greatly, which means a poor tonnage from the mill.

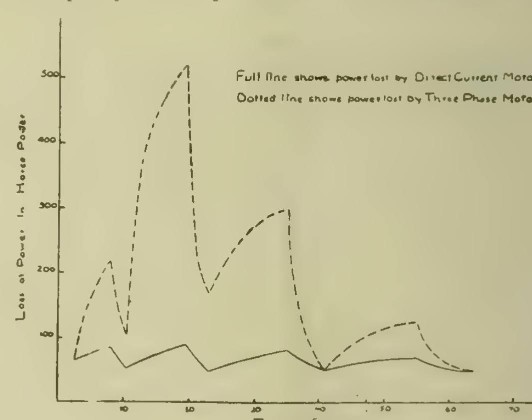


FIG. 2.

Figs. 1 and 2, which give a comparison between the working of a 1,200 horse-power direct-current motor and a 1,200 horse-power three-phase motor driving a mill, illustrate these points.

The full speed of the direct-current motor and the synchronous speed of the three-phase motor are 150 r.p.m., and the speed of each motor is reduced so as to drive the mill at 115 r.p.m. A few passes only are shown in the figures for the sake of simplicity.

Fig. 2 shows that the power lost in the three-phase motor is nearly three times as great as in the direct-current motor, and it should be pointed out that while, if the mill were driven by a three-phase motor, a 1,200 horse-power motor would be required,

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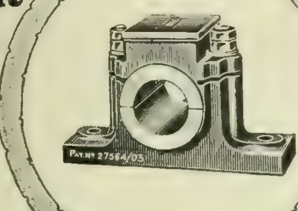

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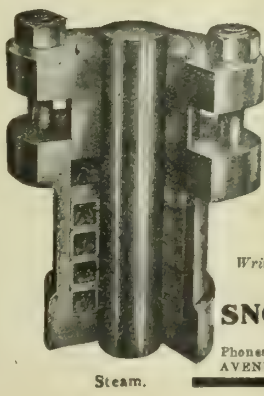

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Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 0 26	0 14 1 24	1 1 2 22	1 8 3 20	1 16 0 18	2 3 1 16	2 10 2 14	2 17 3 12	3 5 0 10	0
1	0 2 25	7 3 23	0 15 0 21	1 2 1 19	1 9 2 17	1 16 3 15	2 4 0 13	2 11 1 11	2 18 2 9	3 5 3 7	1
2	1 1 22	8 2 20	0 15 3 18	1 3 0 16	1 10 1 14	1 17 2 12	2 4 3 20	2 12 0 8	2 19 1 6	3 6 2 14	2
3	2 0 19	9 1 17	0 16 2 15	1 3 3 13	1 11 0 11	1 18 1 9	2 5 2 17	2 12 3 5	3 0 0 3	3 7 1 11	3
4	2 3 16	10 0 14	0 17 1 12	1 4 2 10	1 11 3 8	1 19 0 6	2 6 1 14	2 13 2 2	3 0 3 0	3 8 0 8	4
5	3 2 13	10 3 11	0 18 0 9	1 5 1 7	1 12 2 5	1 19 3 3	2 7 0 11	2 14 0 27	3 1 1 25	3 8 3 5	5
6	4 1 10	11 2 8	0 18 3 6	1 6 0 4	1 13 1 2	2 0 2 0	2 7 3 8	2 14 3 24	3 2 0 22	3 9 2 2	6
7	5 0 7	12 1 5	0 19 2 3	1 6 3 1	1 13 3 27	2 1 0 25	2 8 2 5	2 15 2 21	3 2 3 19	3 10 0 27	7
8	5 3 4	13 0 2	1 0 1 0	1 7 1 26	1 14 2 24	2 1 3 22	2 9 1 2	2 16 1 18	3 3 2 16	3 10 3 24	8
9	6 2 1	13 2 27	1 0 3 25	1 8 0 23	1 15 1 21	2 2 2 19	2 9 3 27	2 17 0 15	3 4 1 13	3 11 2 21	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6·75	13·5	20·25	27	1 5·75	1 12·05	1 19·25	1 26	2 4·75	2 11·5	2 18·25	2 25	

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 12 1 8	7 4 2 16	10 16 3 24	14 9 1 4	18 1 2 12	21 13 3 20	25 6 1 0	28 18 2 8	32 10 3 16	0
10	0 7 0 16	3 19 2 6	7 11 3 14	11 4 0 22	14 16 2 2	18 8 3 10	22 1 0 18	25 13 1 26	29 5 3 6	32 18 0 14	10
20	0 14 1 24	4 6 3 4	7 19 0 12	11 11 1 20	15 3 3 0	18 16 0 8	22 8 1 16	26 0 2 24	29 13 0 4	33 5 1 12	20
30	1 1 2 22	4 14 0 2	8 6 1 10	11 18 2 18	15 10 3 26	19 3 1 6	22 15 2 14	26 7 3 22	30 0 1 2	33 12 2 10	30
40	1 8 3 20	5 1 1 0	8 13 2 8	12 5 3 16	15 18 0 24	19 10 2 4	23 2 3 12	26 15 0 20	30 7 2 0	33 19 3 8	40
50	1 16 0 18	5 8 1 26	9 0 3 6	12 13 0 14	16 5 1 22	19 17 3 2	23 10 0 10	27 2 1 18	30 14 2 26	34 7 0 6	50
60	2 3 1 16	5 15 2 24	9 8 0 4	13 0 1 12	16 12 2 20	20 5 0 0	23 17 1 8	27 9 2 16	31 1 3 24	34 14 1 4	60
70	2 10 2 14	6 2 3 22	9 15 1 2	13 7 2 10	16 19 3 18	20 12 0 26	24 4 2 6	27 16 3 14	31 9 0 22	35 1 2 2	70
80	2 17 3 12	6 10 0 20	10 2 2 0	13 14 3 8	17 7 0 16	20 19 1 24	24 11 3 4	28 4 0 12	31 16 1 20	35 8 3 0	80
90	3 5 0 10	6 17 1 18	10 9 2 26	14 2 0 6	17 14 1 14	21 6 2 22	24 19 0 2	28 11 1 10	32 3 2 18	35 15 3 26	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	36 3 0 24	72 6 1 20	108 9 2 16	144 12 3 12	180 16 0 8	216 19 1 4	253 2 2 0	289 5 2 24	325 8 3 20	361 12 0 16	

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0	..	7 1 8	0 14 2 16	1 1 3 24	1 9 1 4	1 16 2 12	2 3 3 20	2 11 1 0	2 18 2 8	3 5 3 16	0
1	0 2 26	8 0 6	0 15 1 14	1 2 2 22	1 10 0 2	1 17 1 10	2 4 2 18	2 11 3 26	2 19 1 6	3 6 2 14	1
2	1 1 24	8 3 4	0 16 0 12	1 3 1 20	1 10 3 0	1 18 0 8	2 5 1 16	2 12 2 24	3 0 0 4	3 7 1 12	2
3	2 0 22	9 2 2	0 16 3 10	1 4 0 18	1 11 1 26	1 18 3 6	2 6 0 14	2 13 1 22	3 0 3 2	3 8 0 10	3
4	2 3 20	10 1 0	0 17 2 8	1 4 3 16	1 12 0 24	1 19 2 4	2 6 3 12	2 14 0 20	3 1 2 0	3 8 3 8	4
5	3 2 18	10 3 26	0 18 1 6	1 5 2 14	1 12 3 22	2 0 1 2	2 7 2 10	2 14 3 18	3 2 0 26	3 9 2 6	5
6	4 1 16	11 2 24	0 19 0 4	1 6 1 12	1 13 2 20	2 1 0 0	2 8 1 8	2 15 2 16	3 2 3 24	3 10 1 4	6
7	5 0 14	12 1 22	0 19 3 2	1 7 0 10	1 14 1 18	2 1 2 26	2 9 0 6	2 16 1 14	3 3 2 22	3 11 0 2	7
8	5 3 12	13 0 20	1 0 2 0	1 7 3 8	1 15 0 16	2 2 1 24	2 9 3 4	2 17 0 12	3 4 1 20	3 11 3 0	8
9	6 2 10	13 3 18	1 1 0 26	1 8 2 6	1 15 3 14	2 3 0 22	2 10 2 2	2 17 3 10	3 5 0 18	3 12 1 26	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6·84	13·68	20·52	27·36	1 6·20	1 13·04	1 19·88	1 26·72	2 5·56	2 12·4	2 19·24	2 26	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 82 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 13 0 24	7 6 1 20	10 19 2 16	14 12 3 12	18 6 0 8	21 19 1 4	25 12 2 0	29 5 2 24	32 18 3 20	0
10	0 7 1 8	4 0 2 4	7 13 3 0	11 6 3 24	15 0 0 20	18 13 1 16	22 6 2 12	25 19 3 8	29 13 0 4	33 6 1 0	10
20	0 14 2 16	4 7 3 12	8 1 0 8	11 14 1 4	15 7 2 0	19 0 2 24	22 13 3 20	26 7 0 16	30 0 1 12	33 13 2 8	20
30	1 1 3 24	4 15 0 20	8 8 1 16	12 1 2 12	15 14 3 8	19 8 0 4	23 1 1 0	26 14 1 24	30 7 2 20	34 0 3 16	30
40	1 9 1 4	5 2 2 0	8 15 2 24	12 8 3 20	16 2 0 16	19 15 1 12	23 8 2 8	27 1 3 4	30 15 0 0	34 8 0 24	40
50	1 16 2 12	5 9 3 8	9 3 0 4	12 16 1 0	16 9 1 24	20 2 2 20	23 15 3 16	27 9 0 12	31 2 1 8	34 15 2 4	50
60	2 3 3 20	5 17 0 16	9 10 1 12	13 3 2 8	16 16 3 4	20 10 0 0	24 3 0 24	27 16 1 20	31 9 2 16	35 2 3 12	60
70	2 11 1 0	6 4 1 24	9 17 2 20	13 10 3 16	17 4 0 12	20 17 1 8	24 10 2 4	28 3 3 0	31 16 3 24	35 10 0 20	70
80	2 18 2 8	6 11 3 4	10 5 0 0	13 18 0 24	17 11 1 20	21 4 2 16	24 17 3 12	28 11 0 8	32 4 1 4	35 17 2 0	80
90	3 5 3 16	6 19 0 12	10 12 1 8	14 5 2 4	17 18 3 0	21 11 3 24	25 5 0 20	28 18 1 16	32 11 2 12	36 4 3 8	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	36 12 0 16	73 4 1 4	109 16 1 20	146 8 2 8	183 0 2 24	219 12 3 12	256 5 0 0	292 17 0 16	329 9 1 4	366 1 1 20	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

on the other hand, if it were driven by a direct-current motor, a smaller motor than this could be employed with a corresponding reduction in the amount of power lost.

Fig. 1 shows that the speed of the three-phase motor cannot be properly controlled, as it varies from 95·2 r.p.m. to 147 r.p.m. —a variation of 44·8 per cent—the speed rising to 147 r.p.m. when the bar leaves the rolls. The variation in speed of the direct-current motor is 8·5 per cent, this variation being allowed to enable the flywheel to assist the motor, and this speed variation is capable of being reduced. It will readily be understood from Fig. 1 how greatly the output from the mill would be reduced if it were driven by a three-phase motor, owing to the impossibility of keeping the speed under control.

A number of devices have been used to overcome these inherent difficulties of the three-phase motor, and while they enable speed regulations to be obtained without excessive loss of power, and some of them enable the speed to be kept reasonably under control, they usually entail the use of more than one machine, are always much more expensive in capital expenditure, are less economical, and more complicated than the plain direct-current motor.

A USEFUL ENGINEERING PROBLEM.

By EDWARD INGHAM.

THE following problem was set some years ago at one of the honours examinations in applied mechanics by the Board of Education, and since it introduces certain mechanical principles of great importance to all engineers, it is thought that the complete solution will prove useful to readers.

The problem is as follows :—

Find the depth of an engine-guide bar of rectangular section, 10 in. wide and 4 ft. span. The total load on the piston is 25 tons, and the length of the connecting rod is twice the stroke of the engine. Assume the greatest obliquity of the connecting rod to occur when the guide block is at the centre of the span, and that the safe stress of the material is 5 tons per square inch.

This problem is really one on the strength of beams, a subject with which every engineer should be familiar. The guide bar mentioned may be regarded as a beam of rectangular

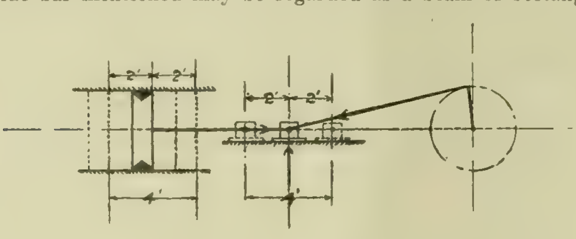

FIG. 1.

section, loaded in the middle with a vertical concentrated load. The first thing to do is to determine the vertical load, or in other words, the downward thrust at the crosshead, resulting from the combined action of the forces acting along the piston rod and the connecting rod. This downward force may be easily determined by the application of the proposition generally termed "the triangle of forces." A line diagram, showing the positions of the piston rod and the connecting rod when the guide block is at the centre of the span, must first be drawn. This is shown in Fig. 1. Having thus got the direction of action of the forces along the piston rod and the connecting rod, and the vertical force at the crosshead, we can draw the triangle of forces in the following manner :

First draw a line parallel to the piston rod, and of any convenient length, which will represent the total load on the piston or on the rod—*i.e.*, 25 tons, the line being drawn from left to right, as indicated by the arrow (see Fig. 2). From the right extremity of this line, draw upwards a vertical line of indefinite length, and from the left extremity another line parallel to the connecting rod, and meeting the vertical line. The triangle thus produced is the required triangle of forces, and the length of the vertical line, measured to the scale used in setting out the force along the piston rod, gives the downward thrust or the upward reaction at the crosshead. The length of the hypotenuse represents the force acting along the connecting rod. It is, of course, the downward thrust which we require.

We find that the concentrated vertical load acting on the guide bar is rather more than 6 tons, but for convenience, we shall assume the load to be 6 tons.

We have now all the information necessary to enable us to calculate the size of guide bar required to resist safely the load to be imposed upon it.

It will be seen that the guide bar is really a beam supported or fixed at the ends, and loaded in the centre with a weight of 6 tons. It is, therefore, necessary to apply the general formula for the strength of a beam.

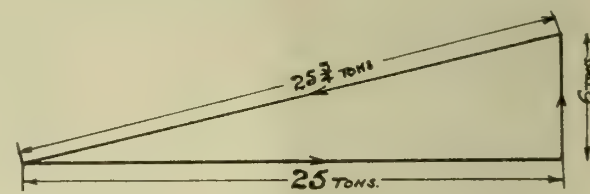

FIG. 2.

This formula is :—

$$\frac{M}{I} = \frac{f}{y},$$

where M = the maximum bending moment on the beam in tons – inches

I = the moment of inertia of the beam section.

f = the maximum stress, *i.e.*, the stress in the outermost fibres of the beam, in tons per square inch.

y = the distance from the neutral axis of the beam to the outermost fibres.

Now the bending moment for a beam supported at the end and loaded in the centre is equal to

$$\frac{W L}{4},$$

where W is the load in tons, and L the length of the beam in inches. Hence, bending moment=

$$\frac{6 \times 4 \times 12}{4} = 72 \text{ tons—inches.}$$

The moment of inertia of a rectangular section about a parallel axis passing through the centre of gravity is :—

$$\frac{bd^3}{12},$$

where b is the breadth of the section and d the depth in inches.

Since the beam section is symmetrical about the neutral axis, the value of y in the general formula will be equal to $\frac{d}{2}$, and it is, of course, d which we require to find.

The value of b is given in the question as 10 in.,

$$\therefore I = \frac{bd^3}{12} = \frac{10 \times d^3}{12}.$$

We are also told that the stress f is 5 tons per square inch. The general formula is

$$\frac{M}{I} = \frac{f}{y}.$$

Rearranging,

$$I = \frac{My}{f}.$$

Substituting the known values,

$$\frac{10d^3}{12} = \frac{72 \times \frac{d}{2}}{5} = \frac{72d}{10}$$

$$100d^3 = 12 \times 72d,$$

$$d^2 = \frac{12 \times 72}{100} = 8{\cdot}64.$$

Then $d = \sqrt{8{\cdot}64}$ = say 3 in

The required depth of guide bar is therefore 3 in. Regarded purely as a beam, the guide bar is of anything but an economical section, since it is much wider than it is deep. This, however, is apart from the problem.

COSTLY PLATINUM. In 1880, one kilo. platinum cost in Paris only 800 fcs., before the war (1913-14) 7,500 fcs., in May, 1917, 16,500 fcs., whilst, after the war, it has rapidly increased till it now costs 50,000 fcs. It is generally believed that this price will rise still further, unless Russia should again soon be in a position to resume her production. The centres of production in the Ural are under the control of the "Compagnie Industrielle du Platine" (Paris), which exercises great control upon the whole market, and whose shares are now quoted at 915 fcs., as against 420 fcs. a year ago.

POWER CONDENSER CALCULATIONS.

A REPLY TO "RADIAN."

The reference to the 2π constant in the article on the above as being somewhat like a conversion of revolutions into radians was intended merely to give a rough idea as to how the 2π came to appear in the formula. If an alternating voltage is a simple harmonic function with respect to time, then the frequency of the supply is the number representing the angular speed of the radius vector representing the voltage in revolutions per second, and 2π will be the same speed in radians per second. Since the radian is the scientific angular unit, the quantity $2\pi f$ is not therefore to be unexpected.

The proof of the formula is as follows: The quantity of electricity in a condenser at any instant is given by $Q = CV^1$, V^1 being the instantaneous value of the voltage. In an A.C. circuit Q is continually varying, and the rate of variation is the current into the condenser, and, moreover,

$$V^1 = V_{max.} \sin 2\pi ft$$

If, then, I be the current,

$$I = \frac{dQ}{dt} = \frac{d}{dt}(CV_{max.} \sin 2\pi ft)$$
$$= 2\pi f CV_{max.} \cos 2\pi ft,$$

the R.M.S. value of I is therefore equal to $2\pi fC$ times the R.M.S. voltage.

The calculation of the current from the number of times the condenser is filled and emptied per second with give an average and not a R.M.S. value of the current.

The calculation of the current by this method is performed as follows:—Since the maximum charge on the condenser changes from + to − each half-period, or $2f$ times per second, the average current is $4Qf = 4CfV_{max.}$

The R.M.S. value of the current is $\frac{\pi}{2\sqrt{2}}$ times the average value, and this R.M.S. value is therefore

$$4 \times \frac{\pi}{2\sqrt{2}} CfV_{max.} = 2\pi fC \frac{V_{max}}{\sqrt{2}} = 2\pi fCV,$$

since the R.M.S. value of the voltage is $\frac{1}{\sqrt{2}}$ times the maximum value.

G. W. STUBBINGS.

THE WELDING OF ALUMINIUM.

According to advices from Madrid, some improvement has been made in connection with the welding of this metal. As is well known, the soldering of aluminium is attended with certain difficulties. Autogenous welding is used; by means of a blowpipe the gas flame (carbide of calcium and oxygen) generates 3,500 deg. of heat. Owing to this enormous heat, an unfavourable influence is exerted upon the physical properties of the soldering points; in addition to this, some time subsequent to soldering, crystal formations set in which still further augment the evil done to the point of soldering. At the International Engineers' Congress, recently held at Madrid, engineer Hernandez Rojas introduced a welding system of his own which, in the opinion of experts at the Madrid Technical Laboratory, merits every recognition. Tests made as to tensile strength showed that fractures never occurred at the points where the metal had been soldered. According to the Rojas process, the usual benzine welding lamp is used, and the place to be welded or soldered is first of all coated with a special preparation in order to prevent any possibility of the formation of crystals.

BOILER CORROSION BY MAGNESIA CHLORIDE.

Written and Illustrated by JAMES SCOTT.

PRACTICALLY all the salts of lime, magnesia, potash, soda, etc., which are dissolved in water, with the single exception of magnesia chloride, are left behind as solid crystalline compounds when the water containing them is boiled. That is to say, they remain in their original chemical condition. These salts are compounds of acids or gases, alkalies, and metals. For instance, lime sulphate consists of the metal calcium combined with sulphuric acid. This, as well as the others referred to, can be recovered as visible powder when the water is heated.

Magnesia chloride—which is a compound of the metal magnesium with the gas chlorine—behaves altogether differently, and is unique among the agents which are destructive to boilers. When water containing it is heated, the salt is decomposed, and is resolved into magnesia oxide and chlorine, concerning which I will say more later on.

Magnesia chloride is derivable from a variety of sources. Both of the minerals, magnesian limestone (this is often called dolomite) and magnesite, or magnesia carbonate, are capable of yielding it, provided the water also contains chlorine evolved from the decaying residue of animal remains.

Water does not need to be still occupied by such carcase *debris* to become injurious to boilers. It may be quite clear of organic matter, yet hold the results of its former presence. All running waters have a connection with others in some way; rain soaking through the soil and rocks, and dissolving out the mineral matter, which is conveyed therefrom to springs, rivers, and so on. The bodies of animals which putrefy in these places provide the chlorine, which is dissolved out and combines with the magnesia separated from the ground to produce magnesia chloride.

Sea water, owing to its high content of sodium chloride (a compound of soda and chlorine), is a rich source of magnesia chloride. Brackish water, and briny land districts where deposits of salt occur, come next in importance of faultiness in the direction now being considered.

Boiler-feed water contaminated with magnesia chloride can be drawn from supplies which are many miles away from the originating area. Water of this nature is more abundant than is suspected by engineers, and if their plates and condenser tubes corrode with mysterious persistence it would always be advisable to seek the advice and help of an expert in water chemistry.

Magnesia chloride can be prepared experimentally by dissolving either magnesia carbonate or magnesia oxide in a dilute solution of hydrochloric acid until the latter is neutralised. The hydrochloric acid releases its chlorine, thus enabling the remarkable compound to come into existence. But, as already pointed out, it cannot be obtained like other salts by means of evaporation under the influence of heat. While this solution is cold it cannot do any harm, and, of course, its mineral content cannot be seen, but as soon as it is heated it begins to split off, or decompose; and when the boiling stage is reached a fine white powder, innocuous magnesia oxide, appears as a cloud of specks which gradually subside as a deposit on the

plates and to the botom of the water, while the pernicious gas chlorine rises from the water, and is readjusted according to its opportunities.

Chlorine, when strong, is greenish or yellowish green, but in the diluted, mixed state under consideration is too faint for any colour to be described definitely. It can corrode metal by itself, but its usual procedure is to combine with the steam and travel about the various spaces above the water line of the boiler, and into adjacent tubes and (if present) condensers, which are very great sufferers in this respect.

The reasons for these facts is because both magnesia and chlorine have a greater attraction for certain gases than they have for each other. Magnesia has a strong affinity for oxygen, and so the magnesia of heated magnesia chloride readily combines with the oxygen of the water. It is on this affinity that the property of magnesium of igniting is based. Readers will know full well that when this metal is heated it quickly blazes up into a blinding flare, which has served for war signals and flash-light photography. The white powder which falls all over the place when the metal is thus burnt is magnesium oxide, precisely the same as that which settles in boilers when magnesia chloride is heated therein. In the one case the magnesia combines with the oxygen of the air, and in the other with the oxygen of the water. By

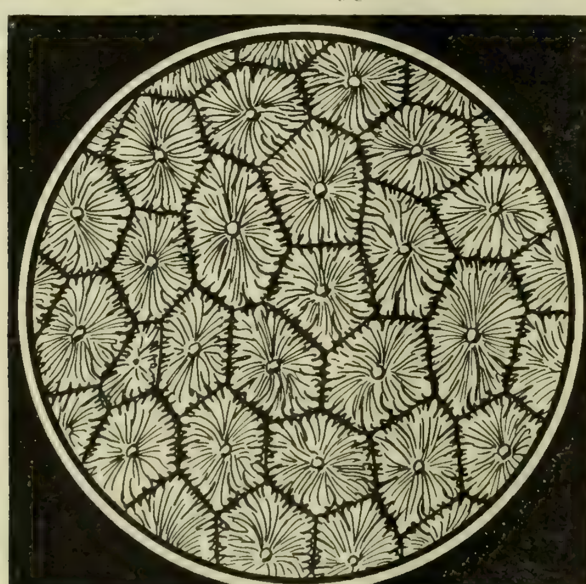

Fig 1.—One twenty-fourth inch of a layer of magnesia oxide produced when water containing magnesia chloride is boiled, hydrochloric acid being at the same time evolved. Magnified.

eliminating this oxygen from magnesia oxide, we can get metallict magnesium again. Chlorine has an equally strong affinity for hydrogen, which it obtains from the globules of steam with which it is mixed, and this combination results in the evolution of dilute hydrochloric acid, and this constitutes the actual offending component.

A mist of hydrochloric acid is caused to contact with the plates, and so on, above the water line of the boiler, where serious corrosion is set up. Such corrosion is never produced—unless the water is exceptionally strong in magnesia chloride—on the plates where the body of water touches them, because of the conduct mentioned, namely, the generation of chlorine from the surface of the water.

Marine boilers which are fed straight away with sea water suffer severely on this account, while the condensed vapour of such water (unless precautions have been taken to guard against the possible results) will usually be contaminated with chlorine and hyrdochloric acid.

What is known as anhydrous magnesia chloride can be obtained by special chemical operations in a closed crucible. But the powder is so unstable that upon exposure to the air it immediately begins to deliquesce, or liquefy, through its automatic absorb-

Fig 2.—One twenty-fourth inch of a layer of ferrous chloride due to the corrosion of steel by hydrochloric acid evolved from magnesia chloride in water. Magnified.

tion of moisture. The resultant mixture becomes ordinary magnesia chloride, and any attempt to isolate the salt by heat will result in its customary separation into magnesia oxide and chlorine.

Magnesia chloride can only be secured in a permanent state by preparing what is called a double salt; that is, a mixture of two compounds. Equal quantities of dilute hydrochloric acid are treated, respectively, with magnesia oxide or carbonate and ammonia carbonate, and then mixed together. Upon boiling this solution, magnesia chloride and ammonia chloride together are formed. As ammonia chloride is volatile at high temperatures, fused magnesia chloride alone is produced when this double salt is suitably heated in a porcelain crucible. But, as soon as this fused compound is exposed to the air, it dissolves to ordinary magnesia chloride, and will yield only magnesia oxide and chlorine when heated.

A special process for the treatment of boiler-feed water, which is affected by magnesia chloride, is based on the preceding double formation, the magnesia chloride being prevented from decomposing into magnesia oxide and chloride, it helping to produce easily blown-out sludge instead. Reverting to the corrosive agents, it should be pointed out that steam impregnated with the separated chlorine, before hydrochloric acid is produced, will bleach coloured

materials held in it. The steam can be tested in this manner.

In boilers where condensed water is repeatedly used the hydrochloric acid is continually carried through the whole system of cylinders and tubes, being responsible for considerable trouble. The accompanying heat increases the corrosive power of the acid.

The damage to steel plates and condenser tubes depends on the action of the hydrochloric acid evolved in the manner explained hereafter. The acid attacks the steel, and forms with is ferrous chloride and ferric chloride. The first is yellowish and greenish and crystallisabl., while the second is reddish brown and non-crystallisable. But intermediate phases, semi-crystalline, and devoid of exact names, are prevalent.

The dissolved metal runs off from the spoilt spots, and may trickle down into the boiling water and irregularly stain the scale. In doing so, it leaves the solid metal corroded by pitting, flaking, and cracking.

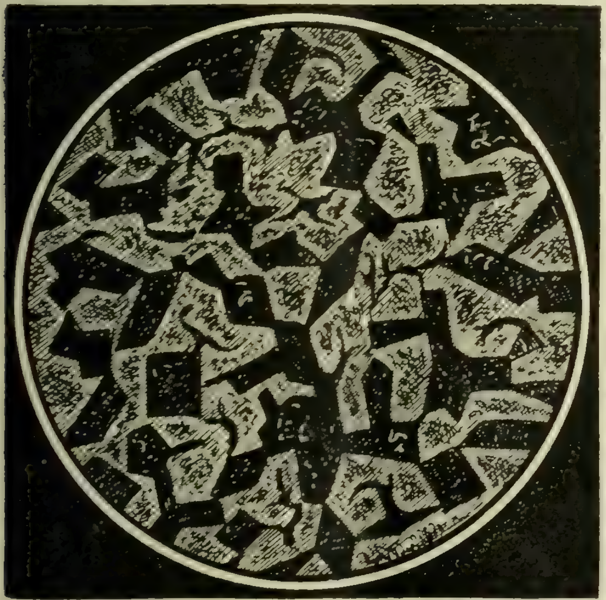

Fig 3.—One twenty-fourth inch of a layer of ferric chloride due to the corrosion of steel by hydrochloric acid evolved from magnesia chloride in water. Magnified.

It should be understood that both ferrous and ferric chlorides contain the real metal modified into a salt, or solution, and this removed iron could be recovered from these detachable compounds, and the extent of the metal abstracted then calculated. The ferrous salt, by absorbing extra oxygen, is changed into the ferric condition.

Suppose we have a boiler which has been badly attacked by the products of magnesia chloride. If work is stopped, and the boiler is emptied and allowed to dry, small sparkling pale yellowish or greenish spots and lines, or reddish shining ones, would be found on the plates and elsewhere, denoting the positions where the salt or solution had settled and induced corrosion.

Copper corroded by chlorine or hydrochloric acid yields a bright green solution, and this, when evaporated, leaves crystals of this colour which become red while hot, and revert to their original green colour when cold.

Water containing magnesia chloride gives an insoluble deposit of silver chloride when it is treated with a solution of silver nitrate. Confirmation is obtained by exposing this precipitate to daylight, when it will turn to a deep purple colour, or become almost black.

Reference may now be made to the illustrations. If magnesia chloride is heated on a glass slide a white deposit of impure magnesia oxide will be obtained, as shown in Fig. 1. When thin, this mineral is in the form of adjoining polyangular plates and discs, which are figured with crystalline tufts and needle-like objects. These are, in thicker layers, blistered up into little balls, which adhere together to produce porous crusts.

In Fig. 2 is shown a typical layer of yellow-green semi-crystalline character, the spaces between the into kindred forms and indefinite substance.

In Fig. 3 is shown a layer of ferric chloride of a semi-crystalline character, the spaces between the objects being occupied by mere streamers and dots of the compound, which elsewhere may be quite scaly and shapeless.

COAL ECONOMY AND THE COST OF LIVING.*

We have, in this country, nearly 40,000 industrial concerns run by steam or gas, and therefore entirely dependent on coal, and, needless to add, it is also the one essential for warming and cooking in our eight million houses, besides heating our hundreds of public buildings.

In the four years preceding the outbreak of war the average annual output of coal was nearly 300 million tons, and the weight per year exported 80 millions, but the output of coal to-day is only at the rate of about 230 million tons, and the coal exported during the last seven years has been respectively 77, 62, 46, 42, 38, 34, and 38 million tons, the reason being that, due to restricted output, home demands taking first claim, exports have had to be proportionately cut down, and as they have fallen, the cost of living has risen.

The trouble due to reduced output of coal does not end here, but as we are now exporting 40 million tons less coal per year our imports are proportionately restricted, the demand again exceeds the supply and the price of every commodity is up.

Coal being our staple industry, its price governs everything else—dear coal means dear metal, such in turn brings about dear machines, and their increased price is then reflected on the output of such machines.

If, now, by paying more attention to our methods of buying coal, we can cut down our home consumption by 50 million tons per year, and this can be done, we should not only be unaffected by the present shortage, but the 50 million tons so saved could be exported and in payment bring into this country over 100 million pounds of produce—the things we have need of—the immediate effect being an all round reduction in the cost of living, because the supplies would more nearly balance the demands.

The brief notes given relative to combustion are not trade secrets, but common knowledge, and the question which persists in coming to the front is, knowing the required conditions for burning coal more economically, why have they not been followed? The echo answers, why?

What would your opinion be of a man who threw 5s. away out of every 20s. he received, and then complained he was short of money. We will not give expression to the opinion, it wouldn't be complimentary, and yet this is exactly what we are doing with our coals to-day, both at home and at our various works.

What is our general practice at home? We allow the fires to burn very low before mending, we fancy this is economical, and then we throw on a shovel full of coal, which cools the fire, and as the gases liberated will not ignite at a lower temperature than 900 degs., before this temperature is reached the gaseous part of

* Extracts from a lecture on "Coal Economy and How its General Adoption would Effect the Cost of Living," by W. H. Casmey, given at the Halifax Technical College, April 22nd, 1920.

the coal, say, 20 per cent to 25 per cent, has escaped as smoke up the chimney. In course of time this method of so-called economy blocks the chimney with soot, and the sweep is called in, therefore our general domestic practice wastes 10 to 12 million tons of coal per year; and, if our eight million houses only cost 2s. 6d. each per year for chimney sweeping, one million pounds sterling may be added to the value of the wasted coals also as lost.

Turn to the boiler house and practically the same conditions are found, and the same remedy should be applied to both, *i.e.*, stoke when the fires are in good condition, clear and bright, and stoke lightly so that a sufficient temperature for igniting the liberated gases is available and smoke cannot then be produced, a high temperature is much easier to maintain than produce.

Seeing then that the temperature of the furnaces is governed by the proportion of air to coal, and this proportion can be indicated by a CO_2 indicator, it is clear that such an instrument is as useful to give the boiler attendant particulars relative to the condition of the fires as the steam gauge and the pressure gauge are to show him the internal conditions of his boiler. Supposing the CO_2 indicator shows 7·6 per cent CO_2 by a very simple calculation, *i.e.*, dividing 19·2 by a percentage of CO_2 and multiplying by 12, the fireman will find he is taking 30 lbs. of air per pound of coal, but if the indicator shows 13 per cent CO_2 the air supply is only 18 lbs., and 800 lbs. of coal will do as much work under the latter conditions as 1,000 lbs. under the former.

With a battery of several boilers it is good practice to fit one boiler with CO_2 indicator and draught gauge and the remainder of the boilers with draught gauge only, and this combination also enables the attendant to secure the same draught through each furnace, and this gauge will also give positive indication should there be air leakage at the downtakes directly into the main flue.

The calorific or steam raising power of coal is judged from the heat units contained per pound. 10 British Thermal Units (B.Th.U.) being the heat required to raise the temperature of one pound of water one deg. Fah. so that to raise one gallon of water (10 lbs.) from 32 degs. to boiling point (212 degs.), 1,180 B.Th.U. would be required, and to turn this into steam at 160 lbs. pressure 10 times as many heat units are required. For steam raising purposes, coal with calorific value of about 12,000 B.Th.U. is generally used, but we have often tested boilers using fuel containing less than 10,000 units.

If coal and air are supplied in the proportion of 1 to 12, the resulting temperature will be 5,000 degs., but which is too high for steam raising purposes; therefore, it is good practice to allow 50 per cent excess air, making the total required for good practical working 18 lbs. of air per pound of coal, the temperature with this mixture being 2,700 deg.

The causes of coal wastage may be summarised as follows :—

Areas of firegrates and outlets at rear of furnace flues out of proportion of area and height of chimney.

Fires too thin, stoking at the wrong time, stoking too heavily, fires given too much or too little air, side dampers not air-tight, coal left in ashes, fires too low before cleaning, drag used too much, lack of draught gauges to enable a battery of boilers to each secure the same draft, boilers badly seated, side and bottom flues too small, uncovered boilers and steam pipes, damp and dirty coal, lack of circulation in boiler.

A nice list of complaints that have held their own since we first commenced to use coal, and about which commissions, Royal and otherwise, have talked, talked and talked, and for the cure of which disease hundreds of patents have been granted, and yet we are wasting nearly 50 million tons of coal, every ton of which could be saved by stopping the leakages enumerated, and to do so presents not the slightest difficulty.

Some one may ask why has the wastage of coal been allowed for so long when its causes are so well known? The correct reply would undoubtedly be, that coals have been so cheap, and the boiler house too hot, dusty, and dirty to be inviting, and so long as plenty of steam was available no one troubled; now, however, the high price of coal makes it imperative that we should secure 30 per cent more of its heat than in the past.

In the manufacture of steel, iron, brass, cloth, dyes, or, in fact, any commodity, definite proportions of various ingredients are used, and the manufacturer is never in doubt as to the results being up to his expectations every time.

In making steam, however, the cost of which is the very foundation of practically all we manufacture, chaos, as a rule, reigns, and it is the writer's object to place the boiler-house on the same commonsense lines as any of the industries which depend upon it.

We know the temperature of combustion is constant, *i.e.*, that a mixture of 1 lb. of coal and 12 lbs. of air produces a temperature of 5,000 deg.; also that when the mixture of coal and air is in the proportion of 1 to 18 the temperature of 2,700 deg. is constant, and that with every pound additional excess air the furnace temperature falls approximately 100 deg., so that when the coal and air are in proportion of 1 to 30 (which may be taken as general practice) the furnace temperature is is only 1,700 deg., and since one square foot of grate at 2,700 deg. will radiate over twice as much heat in a unit of time as a square foot at 1,700 deg. the value of the smaller air supply as a means to economy is self-apparent.

A fire to be effective should be not less than 10 inches thick, it should be maintained at its maximum temperature, and this can be done by stoking it when at its best, for the liberated gases then quickly ignite, and heat instead of smoke is produced.

To secure a smokeless fire, stoking should be on the sides of the fire only, and alternately, *i.e.*, with two boilers the firemen should stoke the right-hand side of each fire, and after waiting a few minutes stoke the left sides, and by this means the required supply of hot air is provided for combustion.

If the fuel used is of the coking kind, the firemen should discard the drag or rake and use the poker only, thus allowing the air free access into the body of the fires.

GENERAL NOTES.

The Final report of the Coal Conservation Committee gives details of an elaborate scheme for supplying electrical power from 16 huge generating stations, and by which means it is assumed 55 million tons of coal per year will be saved. Whilst not criticising the suggestions, the writer would point out that in many industries steam is an essential, and, therefore, the necessity of improving our present methods of producing it should have first consideration.

It will cost large sums of money and many years hard work to bring the super-power stations into operation, whereas the suggestions outlined here, and which, if generally adopted, would save as much coal as the scheme in question, could be working throughout the country in a few weeks at a cost which may be considered negligible.

It has been the aim of the author to emphasise the fact that our coal wastage is not so much due to careless firemen as to conditions over which they have no control. The thorough remodelling on scientific lines of this branch of engineering is a subject to which the Reconstruction Board should give their immediate attention.

The more important conclusions to be drawn from the foregoing may be summarised as follows :—

The temperature of combustion is constant, but too high for steam raising; but with a constant supply of air, say 18 lbs. per pound of excess air, is directly or indirectly equivalent to an additional one per cent loss in fuel.

A flame flued boiler gives its highest duty and efficiency when the firegrates are not more than twice the area of the outlet for the products of combustion at the ends of the furnace flues.

A furnace of 20 square feet area, fed with coal and air in the proportion of 1 to 18, will radiate twice as much heat per unit of time as a furnace of 30 square feet area fed with coal and air in the proportion of 1 to 30.

CONCLUSION.

Any boiler attendant who does not pay attention to the simple elementary laws of combustion gives himself unnecessary work, wastes his employer's money, and floods the atmosphere with dust, soot, foul gases, which gives rise to winter fogs with their long train of expenses and inconveniences, and very materially increases the death rate.

A person's health is largely governed by the quality of air he breathes; the necessity for keeping the air pure is, therefore, apparent.

The law of combustion which governs the boiler furnace applies to the human body, and the point cannot be brought home too strongly, that fresh air is absolutely essential if health is to be maintained, and as soon as we begin to save coals we begin to save life.

Against Piecework.—In the minds of the majority of engineers there is a strong feeling that the system of payment by results would be of no permanent value to them. They fear that it will affect the stability of employment in the future, and unless the employers are prepared to agree with them that the industry should accept the whole or part of the responsibility for unemployment, the system is not likely to be adopted. Hence the majority vote against the system.

DESIGN AND APPLICATIONS OF "HIGH-SPEED GEARING."

By M. Coronel.

(Continued from page 314.)

The bearing shells for these gears are made of cast iron, lined with white metal, which is secured to the shell in the usual way by dovetailed slots, and afterwards hammered into place to make the bearing surface close and hard.

In connection with these gears a few figures for calculating the strength, etc., are given here. The bearings being usually the smallest diameter, they are subjected to an average stress, due to torque only, of about 4,400 lb. per square inch. The pressure on the bearings is about 500 lb. to 600 lb. per square inch of projected area, the surface speed being 500 ft. to 1,200 ft. per minute. The maximum face width of the gears is about half the distance between shaft centres, and should be at least five times the circular pitch. The tooth pressure for steel on steel is about 320 lb. per square inch. The following table gives a few particulars of gears with their maximum and minimum capacity, which may be useful.

TABLE IV.

Centres of Gear.	H.P. Max. Min.	R.P.M. Max. Min.	H.P. R.P.M. Ratio.	Torque on Pinion Shaft.	High Speed Bearing. Size.	Lbs. per sq. in. Stress.	Lbs. per sq. in. Press.	Slow Speed Bearing. Size.	Lbs per sq. in Stress.	Lbs per sq. in Press.	Max. Face Width
Inches.					Inches.			Inches.			Inches.
20	390	300	1·3	82,000	4½ × 11	4,600	220	5 × 13½	5,000	183	
	125	1,200	·104	6,550	2½ × 7	2,050	180	4½ × 11	3,700	64	10
24	650	300	2·17	136,000	5 × 13½	5,500	610	6 × 15	5,000	218	
	165	800	·206	13,000	3 × 8	2,450	230	5 × 1[illegible]½	3,800	178	11
28	880	300	2·93	184,000	6 × 15	4,4[illegible]0	730	7 × 16½	5,000	570	
	490	1,200	·41	26,000	3½ × 9	3,800	148	6 × 15	3,800	52	12
32	1,100	300	3·65	230,000	7 × 16½	5,000	620	8 × 18	5,000	500	
	365	1,200	·393	192,000	3½ × 9	3,800	72	6 × 15	3,800	25	14
36	1,900	300	6·3	400,000	8 × 18	4,800	1,160	9 × 19	4,800	975	
	500	1,200	·415	260,000	3½ × 9	3,500	100	7 × 16½	3,500	20	16
40	2,200	300	7·4	4[illegible]5,000	8 × 18	5,000	1,200	9 × 19	5,200	1,030	
	580	1,200	·485	305,000	3½ × 9	3,800	101	7 × 16½	3,800	27·3	18
45	...	300	...	...	9 × 19	...	...	10 × 19	...	...	
	...	1,200	...	...	4 × 10	...	...	8 × 18	...	...	20
50	...	300	...	...	9 × 19	...	...	10 × 19	...	...	
	...	1,200	...	...	4 × 10	...	...	8 × 18	...	...	22
60	...	300	...	...	10 × 19	...	...	12 × 18	...	...	
	...	1,200	...	...	4½ × 11	...	...	9 × 19	...	...	24
65	...	300	...	...	10 × 19	...	...	12 × 18	...	...	
	...	1,200	...	...	4½ × 11	...	...	9 × 19	...	...	26

The gear cases are fitted with oil gauges, inspection doors, and drain cocks for running off the oil. The pedestals are similarly fitted, and are also fitted with thermometer pockets on top of bearing cap. See Figs. 7 and 8.

Heavy Type Double Reducing Gears, for purposes as above, but with larger reductions.—Where a larger reduction is required than is usually possible with a single reduction gear, say 1 to 7, double reduction gears are employed to get the greater speed ratio. This type of gear is usually made, as an independent duplicate set of the previous type, by extending the bedplate and mounting on it a similar additional casing and one extra set of bearings. See Plate 3. The high-speed is reduced in the first set of gears, the low-speed shaft of which is carried through and forms the high-speed shaft of the next unit mounted side by side with the first. The second reduction is effected in a similar way, so that finally the slow-speed shaft may come in line with the high-speed shaft of the first set. See Figs. 7 and 8. All the previously-described gears have been spoken of as reducing gears, but can, with very little alteration, be made to serve as increasing gears.

On the ring-oiling and other bearings it has been found necessary to provide the bearing bushes with extra extended cages on each side—see Fig. 7—fitting closely to the shaft and having three holes for running off the oil into the pedestal proper. Inside these cages are oil throwers, machined from the shaft, and of the usual pointed collar type. This has been found necessary to prevent the oil from the bearings creeping along the shaft and gradually draining them. The effect is largely due to the fanning action of the gear wheels. The gears described above run at a peripheral speed of from 800 ft. to 3,500 ft. per minute. The circumferential tooth pressure is from 750 lb. to 2,000 lb. per inch of width of tooth, with pitches of 1 in. to 4 in.

Reduction gears are also made of a vertical type, with the high-speed shaft at the bottom and the slow-speed shaft on top. The casing is then split at the centre line of each shaft, in two or three horizontal sections, according to whether the gear is single or double reduction. Reduction ratios up to 1 to 7 can be made in a single reduction, but higher ratios are generally made by double reduction.

TURBINE REDUCING GEARS.

The application of these gears is of comparatively recent date, and has made great strides, especially during the war. It has been proceeding along lines more generally adopted in engine and turbine design than the gears previously described, which have followed the lines of mill gearing. The turbine-reducing gears have been designed with skill, and with great attention to details. They have been made to run at very high speeds of 30,000 revolutions per minute and more, and in some cases for very high powers and for continuous running. For these reasons special attention has been paid to rigidity of design, and to lubrication. Forced lubrication is provided for both gears and bearings, generally from a rotary pump driven direct from the gear shaft by screw gearing, bevel gearing, or less frequently by chain drive. The pressure at which the pump delivers oil to the bearings is about 5 to 7 lb. per square inch. The wheels are sprayed by rows of specially-designed nozzles, on the full width of the working face. Some firms build a kind of housing round the pinion, with very little clearance, to retain the oil.

We now proceed to describe the various turbine gears in use.

SINGLE AND REDUCING GEARS.

In these gears the casing and bedplate are in one casting, together with the bottom half of the pedestals. See Fig. 9. The caps are, however, independent, and can be taken off separately after removing the top casing. The latter is either made in one piece or divided in three pieces, one cover over the central gears and one cover on each side over the bearings. The bearings are fed by forced lubrication brought in at the bottom of the bearing; or, better still, at the side, at about two-thirds of the height from bottom to centre line.

Gears of this class are usually generated with a hob, and consist of two separate single helical wheels of opposite hands with

a spiral angle of 25 deg. to 30 deg. They are generatad on a vertical milling machine, the table of which is driven by a worm and wormwheel. As these gears run at a very high speed, the shape, pitch, thickness and evenness of teeth have to be very accurate. The movement of the generating table has been found not accurate enough for the purpose. Messrs. Parsons ascertained that the inaccuracy in the teeth is due to the inaccuracy of the driving worm and worm wheel; and, after a series of experiments, in 1912 invented and introduced into the rotation of the cutting tool a "creeping" motion, which eliminates to a great extent these errors due to worm and worm wheel. The worm wheel can be produced with very little error when new, particularly if the accuracy is checked from tooth to tooth, but after some time wear sets in, and inequalities are produced which multiply, or rather magnify, themselves in the wheel teeth to be cut. As soon as these facts became known the device above mentioned was designed and introduced, and is now largely used in the production of turbine gears. See Fig. 28.

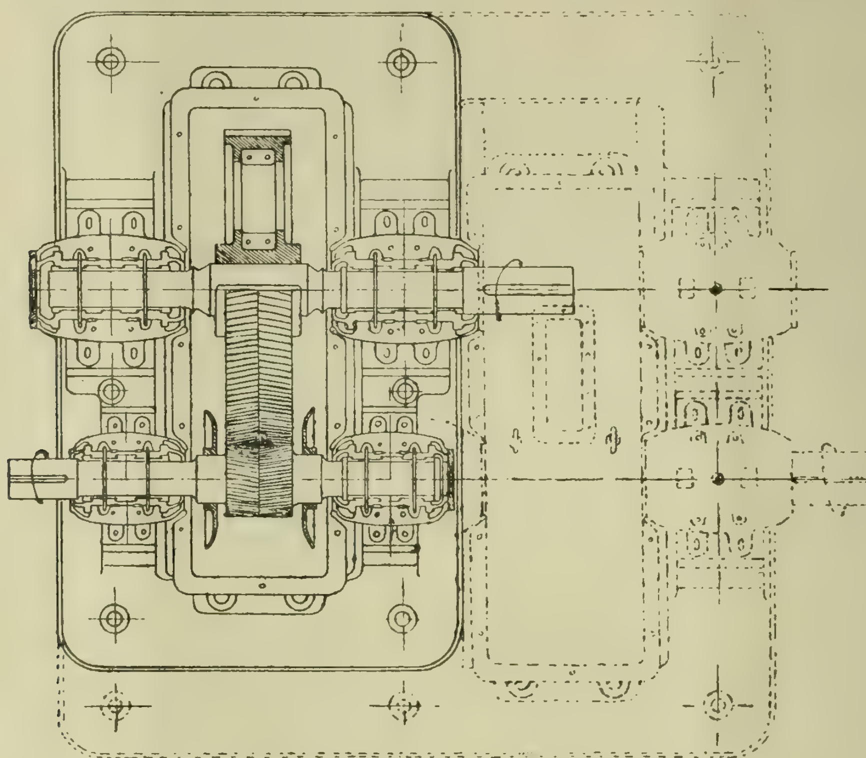

FIG. 7. FIG. 8.

The essential parts of this mechanism are as follows: A worm wheel rotates the table on which the work is to be cut. The worm wheel is slightly eccentric to the work table, and is provided with fine pitch internally projecting teeth, which gear into corresponding externally projecting teeth on a wheel which rotates the work. The gear ratio thus introduced makes the work

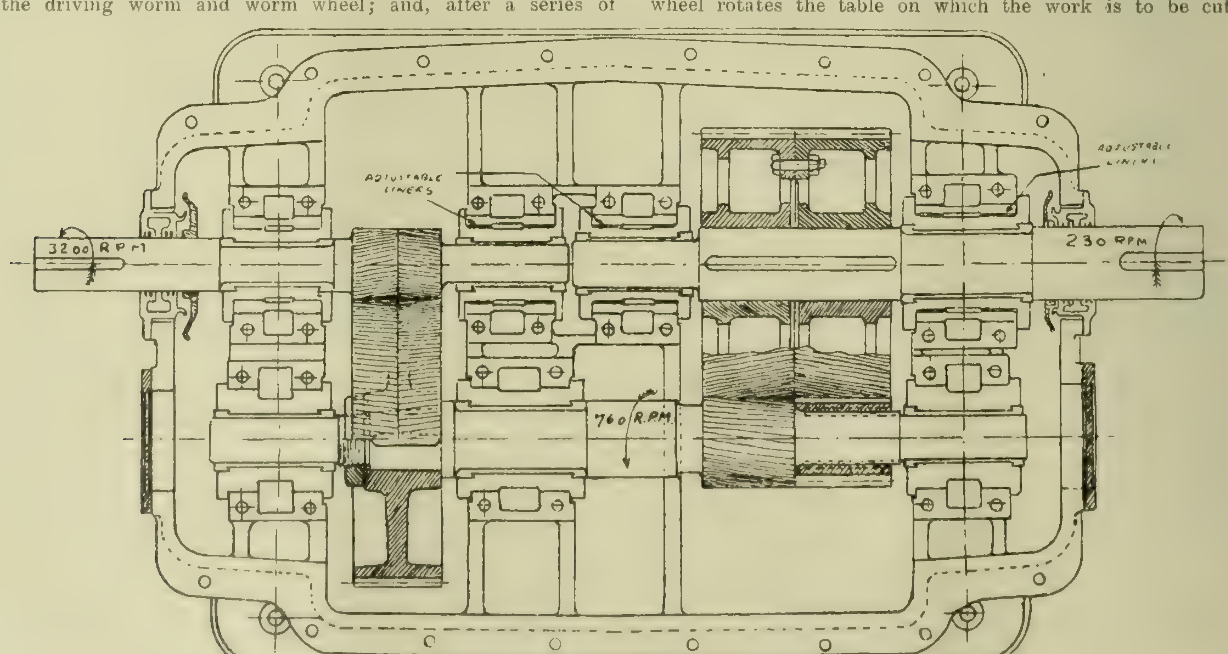

FIG. 11.

table rotate about 10 per cent faster than the parent worm wheel, so that the work itself is constantly changing its position relatively to the teeth of the parent wheel. The error by this arrangement is said to be only one-eighth of the error in the parent worm wheel, instead of being magnified, as in the ordinary driven table. It must be understood that the error is not eliminated, but spread equally over the whole surface of the cut wheel.

The pinions of these gears are generally hobbed in a horizontal

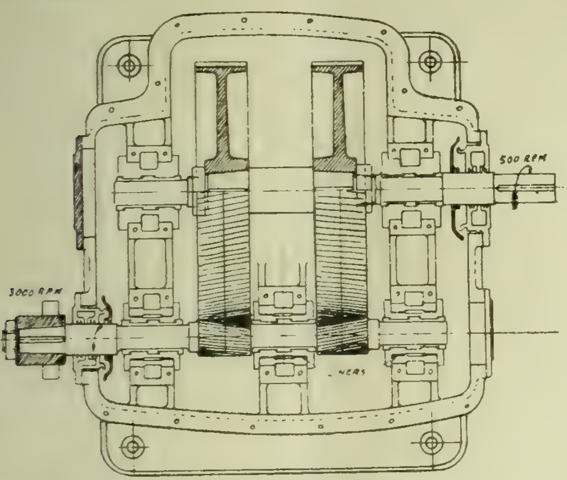

Fig. 9.

position, and are machined from the solid shaft, which is made of ·4 per cent carbon steel with 3 per cent nickel mixture. The pinion face is divided along the shaft; each part is cut as a single helical, one right-handed, one left-handed. Between these two parts a bearing is situated. The pinion shaft is therefore carried by three bearings, the wheel shaft by only two. The wheel is made as a drum, either as a solid steel casting, or as a rim with

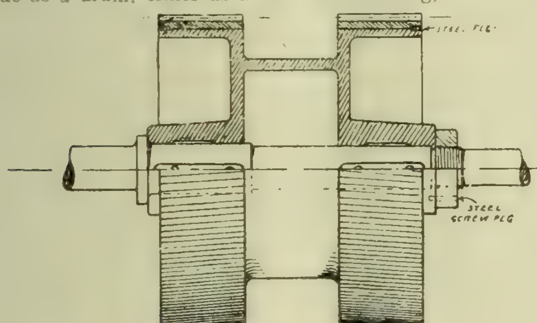

Fig. 10.

two centres shrunk in. In the first case the wheel is made of cast steel, and is formed as indicated in Fig. 10. In the latter case a cast or wrough-steel drum is shrunk on two cast-iron centres, bolted and pegged thereto. See Fig. 18.

The wheel is either secured on a parallel part of the shaft by pressing on and by keys, or on a taper part of the shaft, with a taper of 1 in 10 in. diameter, and secured by a nut and key. See Figs. 9 and 11.

(To be continued.)

A NEW METALLURGICAL GROUP.

The Franco-Belgian-Luxemburg group which has acquired the Luxemburg works of Differdange and Rumelange, and also those of Saint-Ingbert in the Palatinate, all three of which were the property of the German company Deutsche-Luxemburgische B.A.G., has now formed a company entitled Société des Hauts Fournaux et Acièries de Differdange, Saint-Ingbert, Rumelange. The company's capital is 110,000,000 francs. The principal subscribers of capital are: Société Lorraine des Acièries de Rombas (54,825,000 francs); Société Generale de Belgique (21,825,000 francs); Société d'Ougrée Marihaye (8,000,000 francs); Acièries d'Angleur (10,000,000 francs); Banque d'Outremer de Bruxelles (5,000,000 francs); Compagnie Générale des Railways et d'Electricité à Bruxelles (5,000,000 francs); and Mutuelle Mobilière et Immobilière de Bruxelles (5,000,000 francs). The Differdange Works have now rekindled three blastfurnaces, and sufficient supplies of coke are now assured for an indefinite period.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

* Official Lecture: "The Submarine." By H. W. Townsend (Member).

This paper is descriptive rather than deeply technical; nor does its author claim otherwise. Mr. Townshend has presented a clear, informing, and interesting account of the principal features of the submarine. The illustrations are diagrammatic, and they are what diagrams should be. There is no extraneous detailing, and the vital things are there. The text is good.

The author treats of the conditions which in large measure influence the size of vessel. The hull, its sub-divisions, the super structure, and the conning-tower are all described. There are pertinent comments upon the matter of the tank systems. Mr. Townshend considers that fame, and possibly fortune, will reward the inventor who can devise an arrangement for driving both on the surface and below it by means of a single plant. He treats of the compressed-air systems, and of the provision made for storage of certain commodities.

The explanation of steering and steering apparatus are such that he need be no engineer who can understand how the craft is directed by her rudders from one plane of motion into either of the other two. Periscope, wireless installation, and other features are described. Specially interesting is the section concerned with torpedoes and torpedo gear.

Submerging and emerging processes are dealt with, and there is, in conclusion, a paragraph wherein the author indicates the commercial uses to which the craft may be put.

A direct, lettered reference in the text itself to the various items specified in the diagrams might perhaps have been useful as even further clarifying the clear.

This descriptive paper really describes. Need reviewer add more?

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* Official Lecture: "The Design of Flat Plates."
By C. C. Pounder, A.M.I.M.E. (Member).

To the reader who will go to it meaning business, this paper is one which will repay him abundantly. It can be rushed, but it cannot be understood so. It can be understood, but it demands patience; and it is well worth the patience and the application. At the same time the author has explained most difficult and complex matters in a surprisingly clear and convincing way; but the reader must take time, and must not wobble.

Numbers of men are no doubt familiar with the common method for treating simply supported circular and rectangular plates. Very few indeed I imagine had hit upon the device by which fixed plates may be negotiated with sufficient accuracy for ordinary requirements.

Mr. Pounder deals with circular and rectangular plates, plates plain ribbed and box type, and plates under conditions of fixed, of free, and of intermediate support. The general notes should be carefully studied. The summary and the bibliography are most useful features in the work.

Possibly it might be well, for experimental purposes, to make trial with fixed support plates as cast, to compare with those more ideal samples, "milled and ground from the solid." This should yield additional and important comparative data.

The author believes in erecting theory on the sure foundation of experiment. There is room and to spare in that school for many, many more pupils.

The lecture breaks up new ground, and ploughs it well.

* Price: To members, 1s. each; to non-members, 2s. each.

W. Roland Needham.

The San Francisco Aeronautical Show served once again to prove the great superiority of British-built aeroplanes over any others. The opening day of the show was marked by the holding of the race for the Del Monte Aero Classic. Enormous interest had been displayed in this event, and there was great speculation as to the type of machine which would cover most speedily the course of 220 miles. A "Bristol" two-seater tourer, fitted with a 230/240 H.P. Siddeley "Puma" engine, owned by Mr. Menzel, of California, was amongst the competitors. This machine made an excellent start, and from the early stages of the race displayed its superiority over its rivals. Proceeding without a hitch, the course was completed in 102 minutes, an average travelling speed of 129 miles an hour, and was easily the first machine home. The machine had been acquired by the owner through the New York branch of the Bristol Aeroplane Co. Ltd.

Trade Items, Notes, &c.

The "Griplock" Washer.—This is a cone-shaped washer which slips over the thread of the bolt, and when in position can be locked on the top of the nut by simply screwing another nut down on to it. This has the effect of flattening the washer and forcing its inner edge into the thread, round which it fits tightly. The top nut may then be removed. To remove the washer, a cold chisel or a special tool is employed to prise up its edge.

Trade Openings in Poland. In pre war days this market belonged exclusively to the Austrians and Germans, who are now doing their utmost to regain their old ascendancy; in fact, they are making offers to sell goods, allowing for the depreciation of Polish currency. The firm of Bosch, however, have considerably increased their prices, and are asking 1,200 marks for a Z X magneto, and 17 marks for a sparking plug; magnetos have increased 100 per cent in price in three months. Tool steel costs 12/16 marks per kilo.; rapid steel, 100 marks per kilo.; a 220/100 lathe costs 12,000 marks; and a 165/100 rectifying lathe, 32,000 marks. The prices of machine tools are, relatively speaking, low.

Carbonic Acid as a Fire Preventer.—In spite of all precautions, fires frequently occur in places where large quantities of coal are stored. Under present conditions such coal fires are a source of particular danger, where so many war stores are still lying around. The German *Steam Boiler and Engine-Driving Journal* now states that at a large coal dump in Dortmund the coal is now being stacked up in conjunction with the use of carbonic acid, the acid being used in the same way as is commonly employed when coaling ships. Carbonic acid is, of course, much heavier than air, and thus always fills thoroughly even the lowest parts of the coal bunkers. The process is especially suitable when storing coal in high receptacles in which, owing to the height, a coal fire could break out much more easily than usual.

Steam Engine Makers.—A valedictory notice on the Steam Engine Makers' Society prior to its absorption in the Amalgamated Engineering Union, on July 1st, 1920, states that they will haul down the flag with the following obituary notice:—

Steam Engine Makers. Established at Liverpool, November 24th, 1824, and went over to the great majority to form the Amalgamated Engineering Union with a total membership of 500,000. We do so at a time when we were never so prosperous throwing into the common pool for good or ill a sound and efficient membership of 30,000 craftsmen, and a capital of considerably over £300,000, and with these very valuable and tangible assets a status second to none among engineering craftsmen, and with it by far the lowest percentage of unemployed of any of the kindred unions.

The present unemployment is less than 1 per cent. The report refers to the rocks ahead, and urges the vital need of sound and strong leadership and a spirit of order and discipline.

An amalgamation of interests has been arranged between the Lancashire Dynamo and Motor Co. Ltd., of Manchester, and the Crypto Electrical Co. Ltd., of Willesden. It is intended that all machines below about 10 H.P. shall be manufactured at the Willesden works, and that machines above this size shall be manufactured at Manchester. Special arrangements have, of course, been made to meet the requirements of customers who require to duplicate existing machines of either make. The Crypto Electrical Company's works at Willesden are being extended to double their present size. The extensions are practically complete, and a greatly-increased output will be available within a short time. It is hoped that the extensions will ensure the production of approximately four times the existing output of motors from about ¼ B.H.P. up to 10 B.H.P. The selling organisation of the two companies have been combined throughout the British Isles. The associated firms have branch offices in London, Glasgow, Newcastle, Birmingham, Dublin, Cardiff, and Bristol, and full information regarding the products of both works can be obtained from any of these offices, or, of course, from the head offices and works of either firm.

Queensland and Water Location.—Under the head of "The Location of Water Supplies for Settlers," an account is given in the annual report of the Queensland Minister for Lands of the work of testing for water by means of the divining-rod and the Mansfield automatic water-finder, which was done in the past year in that Australian State. It is stated that £797 was expended on this account. During the year 240 sites were located, operations extending as far north as Pentland, and as far west as Adavale and Winton. In addition to the sites located for settlers, a considerable amount of work was done in testing and reporting on areas of Crown land being dealt with for general selection and for soldier settlement. The dry season towards the close of the year occasioned a great demand for the services of the Departmental water-finder, and applications accumulated to such an extent that it was impossible for the diviner to satisfy all demands. Results of operations on sites located during the year were received in 51 cases only. Of these 49 were successful in obtaining good supplies of serviceable water. One site was abandoned on account of the hard strata encountered in sinking, and on the remaining site salt water was obtained after passing through two streams of sufficient quantity, but of quality just about fit for stock. During last year a sub-artesian bore was sunk on the Cooyar Soldier Settlement, and another was put down at Hollywell, in the Cayndah district, and in both cases an adequate supply of good water was obtained. When the year closed the sinking of 10 bores at Mount Hutton, Roma district, had been commenced.

Riveted Joints.—The Transactions (Part V.) of the Institution of Engineers and Shipbuilders in Scotland contains a valuable contribution by a member, Dr. James Montgomerie, on "Experiments on Riveted Joints." Information on this subject has up to the present been somewhat meagre, and it was desired to know—for example—under what circumstances separation of the surfaces of the joint takes place, and what is the comparative effect consequent upon the use of different methods of riveting and of steel or iron rivets in ordinary lap-joints, such as are in common use in shipbuilding. It is considered that the results of this research may be stated as follow: (1) The assumptions underlying the theory on which the design of riveted joints rests are not valid, *i.e.*, the load is not distributed evenly among the rivets, and no uniform state of stress exists anywhere in the joint. (2) For pulls up to the point at which slip takes place the maximum stress occurs in each plate on the surface next the edge of the joint. At this point the stress is nearly double the stress in the normal plate. On the opposite surface the material is practically relieved of stress. The average stress across the thickness of the plate is, therefore, approximately the same as that found in the normal plate. (3) Slip takes place in the joint when the pull applied, distributed over the area of the rivets, produces a stress figure of from 7·5 to 8·0 tons per square inch. Up to that point the joint behaves as an elastic solid. After an interval the joint recovers its power of adhesion, and gives a similar result, on retesting, to that already obtained. (4) The pull-producing slip, when referred to the sectional area of the normal plate, and to the area of the material between a line of frame rivets spaced seven diameters apart, corresponds with a mean stress of 9·0 tons per square inch and 11·0 tons per square inch respectively. (5) No appreciable distinction can be drawn in regard to the elastic qualities or ultimate strength of the joint in respect of the method of riveting employed or the rivet material used. (6) The average strain measured over the whole joint does not materially differ from that found in the surrounding material. (7) In a lapped joint the rivets in the outer rows are more severely stressed than those in the inner rows.

Swiss Machinery in Brazil. The Commercial Secretary to H.M. Embassy at Rio de Janeiro, in a recent despatch to the department of Overseas Trade, transmits a copy of the following letter, which he has received from the Secretary, British Chamber of Commerce, of Sao Paulo (Brazil), with reference to the activities of "The Sociedade Commerciale Industrial Suissa no Brazil": "I am directed by my Council to transmit to you the following expression of their views relative to the method of trade adopted by the Sociedade Commerciale Industrial Suissa no Brazil. It is the opinion that certain Swiss concerns are making considerable headway in the machinery business, which used to be largely in the hands of German concerns, and it is believed that they quite possibly have relations on the other side with certain large German manufacturers. It is almost impossible to make a success of the machinery business in any part of the world unless a competent engineer, with possibly good mechanics under him, is employed by those charged with the disposal or handling of such material. In addition, stocks of the machinery must be kept, as well as a reasonable quantity of spare parts. As far as the Sociedade Commerciale Industrial Suissa no Brazil

is concerned, it has sold and erected plants for cold storage at Santos, Pelotas, Rio Grande do Sul, and other points in Brazil, and has managed to compete against other supplies owing to the fact that it had something definite to show in the way of machinery and stock, spare parts, invoices of machinery in transit for stocks, etc. The firm is represented by someone able to answer and discuss technical questions in five or six languages, or prepare plans for alternative schemes covering installations for packing houses, electric railways, heavy Diesel engines, cotton spinning and weaving mills, hydro-electric power plants, etc. The opinion is that British manufacturers should adopt the same principle; they might consolidate a joint interest in a similar development representing distinct lines of engineering which do not clash one with the other, and place same in charge of the large British merchant firms established at such points, provide them with properly-paid and highly-competent men to manage such engineering departments, and through the channels already opened by such merchants, make a definite bid for all engineering business which from time to time presents itself. It may take one, two, or three years before results would show on the right side, but if the business is handled thoroughly, good results are inevitable eventually. The prospective customer the world over desires to see what he is buying, or at least, a more definite idea of what to expect than will come to hand by letter in answer to an advertisement in some journal. Many buyers know what they require, but there are others who do not know what they want until they see a blue print of what they do not want."

SALVING WASTE.—Owing to the ever-increasing costs of production, engineers and motor manufacturers and repairers will readily welcome any scheme for salving anything which hitherto has been waste. Used oily rags have always been a source of despair to the storekeeper or foreman who takes a pride in his clean workshop. What was the use of saving them? There was no market. To-day, things are different; as, amongst other things discovered during the war, was the way to treat oily rags, and turn them to profitable account. The oil once extracted, the rags are cleaned and sterilised and sold back to the mills, where they are of use to the manufacturers of paper, shoddy, etc. The importance of this saving was fully realised by the Ministry of Munitions, who, at very great expense, opened a special factory to treat this material. Mr. L. St. Clare Roberts, having had considerable experience in the treatment of oils and fats in Australia, was appointed manager of this factory, and a thoroughly up-to-date business was built up, resulting in a great saving to the country. These works were closed down soon after the signing of the Armistice, but, fortunately for those interested, Mr. Roberts purchased the whole of the specially-installed plant and transferred it to his new mills at Plaistow. A new company has been formed, styled Roberts, Paton and Co. Ltd., and although the extensions and alterations to their new premises are not yet complete, they are already getting in touch with all old customers and very many new ones. Briefly, their scheme of working is this: They will supply and deliver steel drums, free of charge, by their own vans within the London area, and free on rail for their country customers. Into these drums all the used oil rags can be thrown, thus keeping the floor clean. When the drums are nearly full a postcard is sent to Roberts, Paton and Co. Ltd., who collect the full drums, and leave empty ones in exchange. For all oily rags collected they pay a very liberal amount, varying according to the market. At present the price is about 4s. per cwt. Apart from the boon of having clean works, and the saving effected by having them removed free of all cost, there is on this price a saving of £4 per ton on the new cleaning rags, and in many shops it does not take long to use a ton of rags. While on this interesting subject, we wonder if many engineers have ever considered the saving effected by the use of rags instead of waste. We have recently seen the catalogue of one of the largest firms who specialise in the supply of everything for the motor, and noted that the price quoted for waste was 94s. 6d. per cwt. To-day's price for washed rags is 50s. to 60s. per cwt. Here is a difference of 30s. 6d. to 44s. 6d. per cwt. With a view to ascertaining the relative absorbent values of the two materials, the Ministry of Munitions had tests made in their Holloway factory, where Mr. Roberts was able to prove conclusively that rags were 9 per cent more absorbent than waste. The result of these exhaustive tests was that rags were afterwards adopted as the standard material for cleaning mechanism in all the workshops of the Royal Air Force. Large engineering firms are rapidly following their example, as they fully realise the necessity of economy to-day. Messrs. Roberts, Paton and Co. Ltd. go one further by paying for the old rags, which have hitherto been valueless.

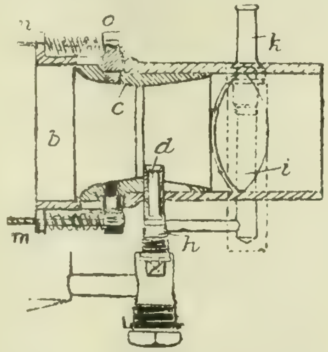
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

128,666.—C. BROWN, 53, Bayswater Road, Birchfield, and BROWN AND BARLOW, Westwood Road, Witton, both in Birmingham.—Aug. 30th, 1917.—The area of the air passage b at the nozzle d of a spray carburettor is varied by a sliding internally-coned choke-



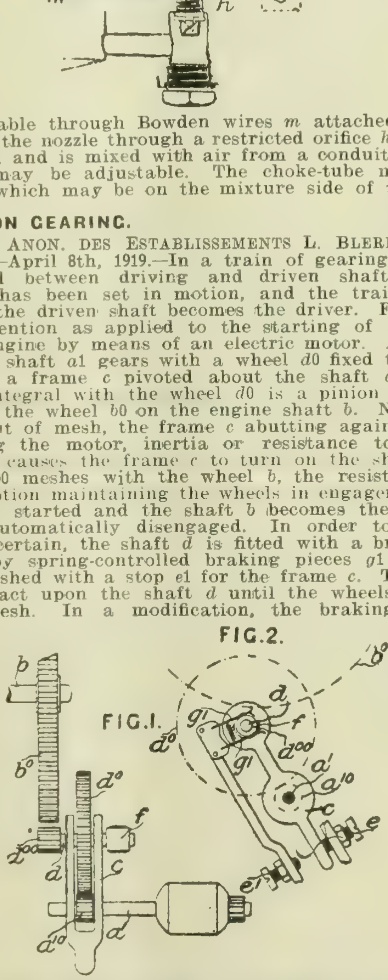
tube c adjustable through Bowden wires m attached to lugs o. Fuel passes to the nozzle through a restricted orifice h, which may be submerged, and is mixed with air from a conduit i, the inlet k to which may be adjustable. The choke-tube may uncover an air port, which may be on the mixture side of the nozzle.

TRANSMISSION GEARING.

128,900.—SOC. ANON. DES ESTABLISSEMENTS L. BLERIOT, 14, Rue Duret, Paris.—April 8th, 1919.—In a train of gearing, connection is established between driving and driven shafts after the driving-shaft has been set in motion, and the train is disconnected when the driven shaft becomes the driver. Figs. 1 and 2 show the invention as applied to the starting of an internal-combustion engine by means of an electric motor. A pinion $a10$ on the motor shaft $a1$ gears with a wheel $d0$ fixed to a shaft d journaled in a frame c pivoted about the shaft $a1$. On the shaft d or integral with the wheel $d0$ is a pinion $d00$ adapted to mesh with the wheel $b0$ on the engine shaft b. Normally the wheels are out of mesh, the frame c abutting against a stop e. Upon starting the motor, inertia or resistance to motion of the wheel $d0$ causes the frame c to turn on the shaft $a1$ until the pinion $d00$ meshes with the wheel b, the resistance of the shaft b to motion maintaining the wheels in engagement. When the engine is started and the shaft b becomes the driver, the wheels are automatically disengaged. In order to render the action more certain, the shaft d is fitted with a brake drum f acted upon by spring-controlled braking pieces $g1$ attached to an arm furnished with a stop e1 for the frame c. This brake is arranged to act upon the shaft d until the wheels $d00$, $b0$ are in proper mesh. In a modification, the braking pieces are

FIG.2.

FIG.1.



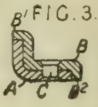
mounted on the frame c and an abutment is provided for separating the pieces and so releasing the brake when the wheels come into mesh.

PISTON PACKING.

129,065.—J. S. HECHT, The Chalet, Russell Avenue, and A. T. DOWDELL, 20, Brampton Road, both in St. Albans, Hertfordshire.—May 29th, 1918.—In metal packing rings of cup-leather type divided at one or more points, the joints are covered by plates made to conform to the section of the ring and having flanges overlapping the edges of the ring. In the form shown in Fig. 3, a plate B is formed with flanges B1, B2 entering recesses in the edges of the packing-ring at the joint. The plate may be riveted to one end of the ring, as shown. Alternatively,

the plate B may be dispensed with, one end of the ring being made of the section of the plate and overlapping the other end of the ring. In this construction the ends may be halved or of unequal thicknesses, or bevelled, and the faces in contact may

FIG. 3.



be corrugated, etc. In a modification, one ring of the section of plate B is nested in an ordinary ring. In the case of a ring consisting of two overlapping turns, the inner turn is made of the section of the cover-plate B. Specifications 8571/15, 16120/15, 123,328, 123,333, and 123,335 are referred to.

LUBRICATING.

129,111.—MOTOSACOCHE SOC. ANON. and A. ISLIKER, 56, Route des Acacias, Geneva.—July 3rd, 1918.—To prevent oil which escapes from the connecting-rod bearings of a two-stroke-cycle internal-combustion engine from entering the passage q, by which gases pass from the crank chamber to the cylinder, the oil is collected in grooves $x3$ at the ends of the bush $x2$ of the connecting-rod x, and is discharged through nozzles $x6$ by the action of inertia or centrifugal force. The grooves $x3$ may be formed in the cylindrical part of the bush $x2$, or in the end faces, or in the rounded

FIG. 6.

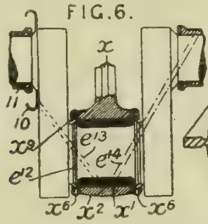
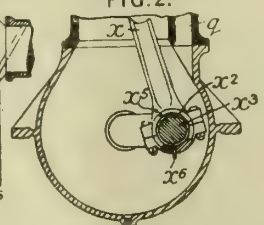


FIG. 2.



corners of the bush. The discharge nozzles may be placed in other portions, such as $x5$. The nozzles may be formed in pointed projections on the connecting-rod or on the flanges of the bush. As shown in Fig. 6, the crank-pin is formed with ribs e12 which deliver oil to grooves $x9$ conected to nozzles $x6$. The two grooves may be connected by a passage discharging by a single nozzle. The device is so arranged that the discharge takes place when the gases in the crank-chamber are almost at rest. Oil is supplied to the crank-pin bearing by a passage e13 from a trough 10 at the end of a shaft-bearing 11; or under pressure by a passage e14.

BEARINGS.

129,056.—A. H. HINDLE, 23, Glenthorne Grove, Brooklands, Cheshire, S. W. SAVAGE, 55, Brook Road, Chorlton-cum-Hardy, A. E. DABBS, 19, Rowan Avenue, Whalley Range, and A. LIDDLE, 3, King's Road, all in Manchester.—May 1st, 1918.—A resilient race for a ball or roller bearing consists of a close metal coil supported in such a way as to provide a clearance space along

FIG. 5.

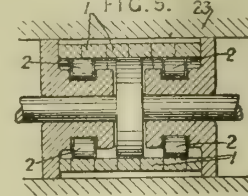
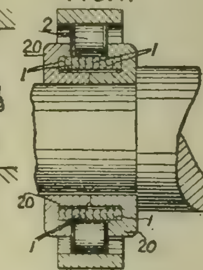


FIG. 4.

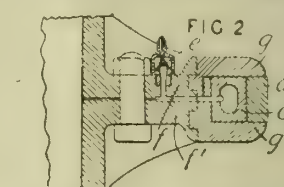


its whole length. The coil 1, Fig. 4, which may be the outer or inner race, is supported by cylindrical ledges on the parts 20. The coils may be of wedge section tapering inwardly. As shown in Fig. 5, the coil 1 engages a central collar 23 on the shaft and rotates on rollers 2 supported on fixed bearing-surfaces. The coils may be made to interengage by forming the sides convex and concave.

PISTON PACKING.

129,141.—H. HEWINS, The Elms, Grimsby, Lincolnshire.—July 18th, 1918.—In a double-acting pump for liquids or air, etc., the piston packing-ring a is expanded by a hollow rubber or like ring d to the interior of which the fluid operated on is

FIG 2



admitted through passages and check valves e, which are provided on both sides of the piston. In the arrangement shown, the piston consists of plates f, $f1$ on the peripheries of which brass rings g, $g1$ are cast.

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CONTENTS.

EDITORIAL.

INDUSTRIAL DISCOVERY.

IT was a foregone conclusion that, with the termination of war, there would be a period of quietness in regard to the launching of new inventions. Much lost ground has still to be made up, and it is a generally recognised fact that the patent agent is busiest when trade is slack. So much renewal and repair work has to be done that the manufacturer has little time to concern himself with the development of new ideas.

That we are advancing out of the period of inactitude is manifest, and, moreover, there is every reason to believe that we are on the eve of important developments in engineering chemistry and electricity. One particularly favourable feature results from the variety of work undertaken by engineers and manufacturers generally throughout the war. The entirely different character of mechanism made, the need for research, and the adoption of methods hitherto foreign to a particular trade have been a remarkably useful piece of education.

No one can doubt that greater co-operation and co-ordination will be one result of the common effort made between 1914 and 1918. Evidence is forthcoming that most excellent economic and efficient results have been achieved through adoption of methods learnt in war-time production.

But the basis of real industrial discovery and invention lies in research. Throughout the world there is a very marked tendency to establish associations for the purpose of investigating matters in relation to industries that for many years have appeared hidebound in their conventions and practice. It means a very searching enquiry, and a start at the very lowest point, if any lasting good is to accrue.

Handicapping our efforts all the time is, in many cases, a lack of tabulated information, which is available to all manufacturers. The writer remembers, in the early stages of the war, how one investigator traversed ground which had previously been covered and wasted months in arriving at a point, information in relation to which was available. There must be many such cases, and some method of disseminating information of this character should be part of the work of the various research associations.

Recently a new discovery in regard to rubber has been made. From the published accounts, it would appear to be a most notable and valuable invention, although on the face of it it appears to be a simple matter. It is merely a new method of vulcanising rubber, but its applications are considerable, and if all the claims are fulfilled, then a very considerable expansion of the industry may be looked for.

ELECTRIC DRIVING.

By E. Austin.

One of the greatest aids to production in engineering works is electric motive power. The possibility of being able to couple powerful motors to individual heavy duty machines is a matter of no small importance for tools that are limited in their production by slipping belts are a source of hinderance and expense. Any amount of power within the limits imposed by tools can be obtained by means of the individual electric drive, and the output of innumerable machines has been increased by operating them in accordance with this method. The elimination or reduction of overhead shafting and belting, moreover, gives more headroom for cranes and hoists, and minimises the risk of accidents. Furthermore, the individual drive allows the speed of machine tools to be regulated electrically, facilitates the re-arrangement of existing machines or the erection of new machines, and enables rush jobs to be worked upon at night or during week-ends, without having to run the entire driving equipment. To these advantages must be added the important fact that electric motive power is very economical, and in many places where motors have been installed in place of old and inefficient engines, the saving in the working expenses has been immense.

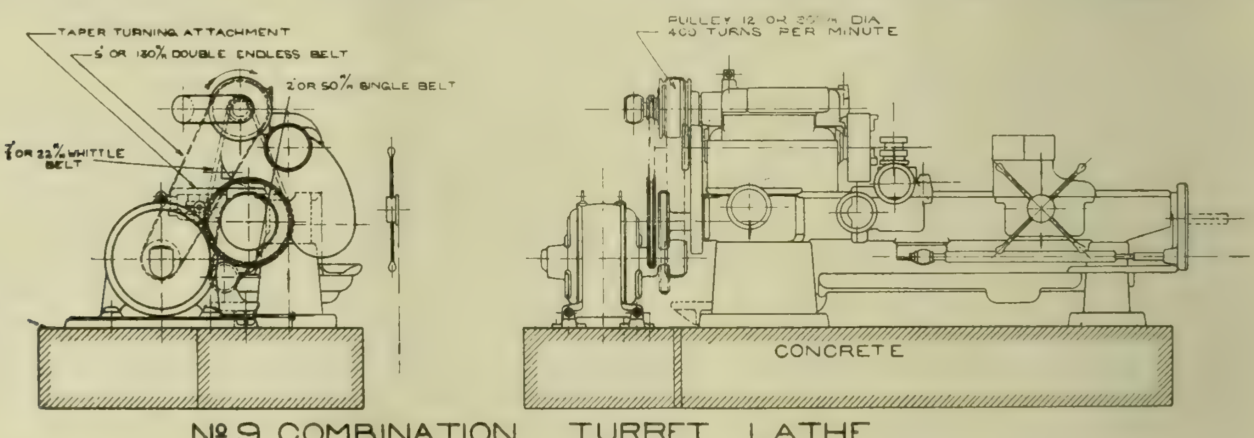


Fig. 1.—The Arrangement of a Whittle Belt Drive applied to a Lathe. (Alfred Herbert Ltd.)

Small and light tools can be grouped together and driven from an overhead line shaft in the ordinary way, but for heavy duty tools, such as large lathes, boring mills, planers, etc., the individual driving system is infinitely better. Indeed, the system is frequently applied to comparitively light tools, such as medium sized drilling machines, which are then amenable to electrical speed regulations. Generally speaking, however, variable speed motors are only used in works supplied with direct current. The speed of a suitably designed direct current motor can be varied over a fairly wide range, and can be varied in fine increments. An induction motor, on the other hand, lends itself to speed regulation much less readily, and in the majority of works in which these motors have been installed, all the speed regulation is obtained by the usual mechanical arrangements. The same applies to many works in which direct current motors are in use, but in this case the question of whether certain machines shall be regulated partly electrically or entirely mechanically, is to a large extent a matter of choice. Fine speed variations can, it is true, be obtained with induction motors by inserting resistance in the rotor circuit, but when motors have to run at low speeds for long periods this method is very wasteful. What is occasionally done, however, is to obtain the wide speed variations by changing the number of poles and the intermediate speeds by an adjustable rotor resistance, and as the pole changing method is not wasteful a better efficiency over the entire range of working speeds is secured.

When works are supplied with polyphase current the squirrel cage induction motor, the simplest and most robust of all motors, should be used as far as possible. The squirrel cage machine in unsuitable for starting machines which involve the acceleration of heavy masses, but it is nevertheless possible to make these machines meet many of the conditions met with in machine shops. With friction clutches, for example, which take up the load after a predetermined speed has been reached, tools which cannot be started by direct coupled squirrel cage motors can be set in motion, but when a very heavy starting torque is necessary, a slip ring induction motor should be employed. The starting torque of a squirrel cage motor is dependent upon the resistance in the rotor circuit, and the torque can be increased to any desired value by increasing the resistance of the rotor end rings. Permanent rotor resistance, however, lowers the working efficiency, and a motor with an adjustable rotor resistance which can be entirely cut out of circuit, when full speed has been reached, is therefore requisite for starting machines that require a very heavy starting torque. Induction motors have been made with automatic rotor switches, which cut out the resistance at a predetermined speed, and these motors can be started simply by closing the main switch. Other induction motors are made to develop a good starting torque without an unduly heavy starting current by altering the connections of the rotor windings by means of a switch operated by centrifugal force, a motor of this type being manufactured by Bruce Peebles Ltd. Small squirrel cage induction motors, with outputs up to about 3 H.P., can be started by directly connecting them to the supply circuit, but larger machines must either be started by reducing the pressure by means of an auto transformer, or by altering the stator winding connections in accordance with the "star delta" principle.

Too much emphasis cannot be laid upon the importance of employing motors possessing the proper

characteristics. When works are supplied with direct current there are three distinct types of motors to be considered, *i.e.*, shunt, compound and series motors. The shunt motor, like the induction motor, runs at practically constant speed at all loads, and broadly speaking, this type of machine is used for driving tools which are easily started and which are not subjected to heavy peak loads, whilst compound motors are used for driving tools which require a considerable starting torque, and machines which perform heavy work intermittently, such as punches,

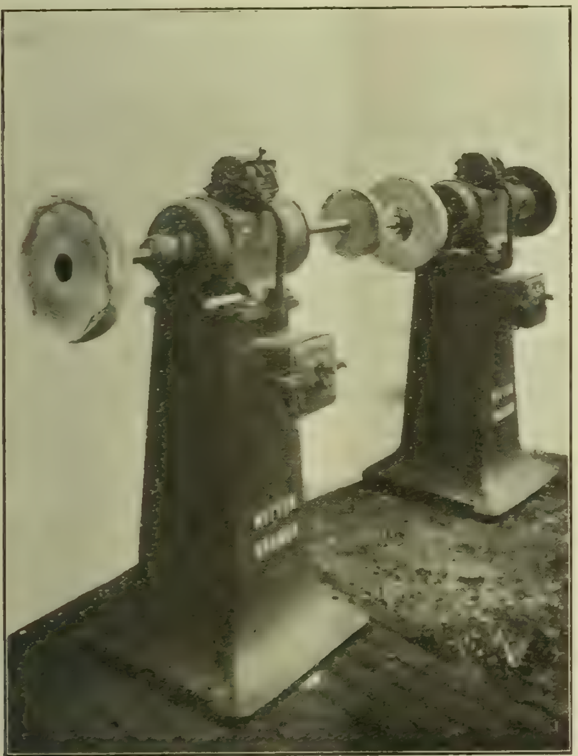


Fig. 2.—Electrically Driven Polishing Luffs. The Witton Kramer Co.,

shears, and so forth, most machines of this class being fitted with flywheels which give up their kinetic energy when the heavy demands for power occur. For driving such machines, a compound wound motor is requisite not only because it will start against heavy loads, but also because at times when the load is heavy the speed diminishes, and so enables the flywheel to cope with the "peak." The amount by which a compound motor decreases its speed at times of heavy loads is governed by the number of heavy section field turns, through which the main current passes. Many motors used for machine tool driving are slightly compounded in order to secure stability and to facilitate starting, but when it comes to the operation of machines subject to heavy intermittent loads, the compounding effect must be more pronounced in order to obtain the speed reduction necessary at the times of peak loads. Series motors develop a very powerful torque at starting, but owing to the fact that the magnetic field is obtained entirely by the main current in the field series coils, these motors should never be used for driving machines that are liable to be entirely relieved of their loads, as the speed is then apt to attain a dangerous value. Series motors are very suitable, however, for driving cranes and hoists, and in engineering works they are employed mainly for work of this description.

The use of good switch gear for starting motors is a matter of great importance. In some cases, ordinary hand operated starters and regulating switches are used, and they may be directly attached to the motors, or mounted in switch pillars, or on walls. Switch gear of this sort is satisfactory if properly handled, but the use of automatic starters is now rapidly increasing. The advantage of these starters is that machines can be started, stopped, reversed, and regulated simply by pressing buttons which can be fixed in any position on the tools, thus enabling operators to control their machines without moving to the point where the starter itself is situated. With an automatic control system of this sort there is no risk whatever of motors being started too rapidly, and as the motor currents are dealt with by clapper switches or contractors, similar to those used on electric trains, there is no risk of destructive sparking occurring at the contacts. The press buttons simply control pilot circuits carrying very small currents, and these circuits control the main clapper switches which can deal with the heaviest currents which engineering work entails. For the control of large and powerful motors these automatic systems are indispensable, because heavy currents cannot be dealt with by ordinary face plate starters.

In a great many cases machine tools are coupled to their motors by means of spur gearing, but silent chain drives may also be adopted on lathes and similar machines. A chain not only gives a positive drive, but it also

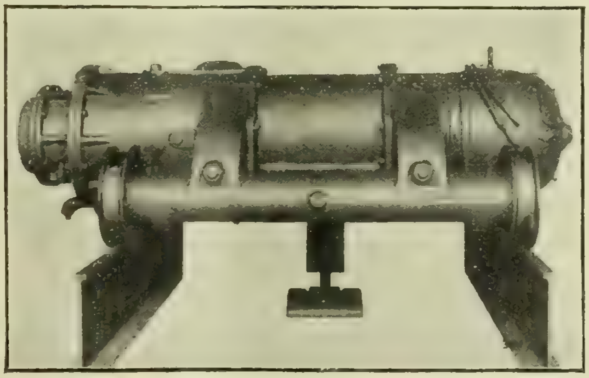


Fig. 3—The Lifting and Travelling Unit of an Electrically Operated Crane. (The Shepard Crane and Hoist Co.)

gives a certain amount of flexibility and is silent and efficient. Whittle belts with proper tightening arrangements (see Fig. 1) have been used with marked success by Alfred Herbert Ltd., and these belts are found to give a very smooth and flexible drive free from the shocks and jars sometimes experienced with other arrangements, and at the same time devoid of belt slipping troubles. On no machine has the individual drive shown up to better advantage than on the planer. The Lancashire electric driving equipments made by The Lancashire Dynamo and Motor Co. have proved eminently satisfactory wherever installed, and cutting and return speeds have

been secured greatly in excess of those obtained with the original belt drives. The system involves gearing a reversing motor to the planing machine and supplying this motor with current from a motor generator set, which is made to give different voltages, and at the end of the planer's stroke the direction of the generator current is reversed, thus causing the motor to run in the opposite direction and to reverse the table. The different cutting and return speeds are obtained by means of an adjustable resistance in series with the generator field circuit, and in order to speed up the table on the return stroke the field of the motor is automatically weakened. Moreover, prior to the reversal of the table, and during deceleration, the planer motor is driven as a generator by the energy stored in the moving parts, and the current so

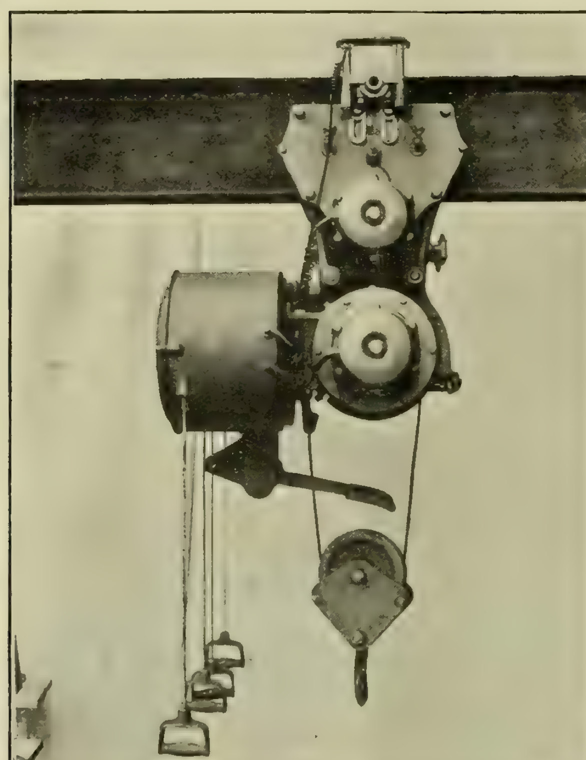


Fig. 4.—An Electrically Operated Mono-Rail Hoist. (The Shepard Crane and Hoist Co.)

obtained is fed back through the motor generator into the supply mains, the dynamo of the motor generator acting as a motor, and the motor as a dynamo. On the cutting stroke 20 different cutting speeds can be obtained, ranging from the lowest speed any particular work demands, to the highest cutting tools will stand with a margin for future improvements in tool steel. Return speeds can also be obtained which are greatly in excess of those obtainable with the ordinary belt drive. Moreover, as the stored energy which is usually wasted, is returned to the supply circuit in the form of electricical energy, the equipment is very economical. The electric braking brings the table to rest in a perfectly smooth manner, and as reversal always occurs at exactly the same point the length of each cut is precisely the same.

Apart altogether from the operation of large stationary machine tools, electricity may be used with advantage for the operation of small motors, such for instance, as motors for driving grinding wheels or polishing buffs as shown in Fig. 2. These particular motors (made by the Witton Kramer Co., of Witton, Birmingham), are mounted on pedestals with the switch gear on the front, but bench grinders and polishing buffs are also made. The application of electricty to portable tools, such as hand drills and grinders, is also very advantageous in the workshop, for these tools are very efficient and easily handled, and unlike compressed air tools they do not demand the installation of a compressed air plant.

For the operation of cranes and hoists, electricity is invaluable, but this is a matter which really demands separate and distinct treatment. So far as cranes are concerned, it must suffice on the present occasion to direct attention to the very simple and compact hoisting and travelling unit fitted to the Shepard electric travelling cranes (see Fig. 3). All the operating mechanism for hoisting and travelling is enclosed, the casing bridging the two I girders, and a more simple and more robust arrangement would be difficult to imagine. For feeding machines, benches, etc., which cannot be reached by the ordinary travelling crane, nothing is more suitable than an electrically operated monorail hoist as shown in Fig. 4. This particular hoist made by the Shepherd Crane and Hoist Co., carries the load electrically, but other hoists are also made which are simply fitted with a hoisting motor, and after the load has been raised from the ground the operator pushes the hoist along the under flange of the I girder by means of a handle. There are, of course, also electric telphers or monorail with cabs in which the driver sits, but electric travelling hoists of the type illustrated are widely used in engineering works.

Training of Hydro-Electric Engineers.—In March, 1919. Professor A. H. Gibson read before the Society a paper* in which he pointed out the necessity for developing water powers within the British Empire, and, as a corollary to this, the need for providing in this country opportunities of training for hydro-electric engineers. While definite courses are conducted in such institutions, for example, as Cornell and McGill Universities, and in many of the Continental technical institutions, very little is done in the British universities and colleges, compared with, say, the courses of instruction in the study of steam engineering. As a consequence of this, the design and manufacture of hydro-electric machinery have generally been entrusted to Continental firms, and of the few really large hydro-electric installations, for which British establishments have been responsible, the greater part of the hydraulic machinery has been made abroad. In these circumstances it is interesting to learn that Sir W. G. Armstrong, Whitworth and Co. Ltd. have now taken up the manufacture of water turbines, and have established a Hydro-Electric Section of their Civil Engineering and Contracting Department. They are, therefore, in a position not only to deliver water turbine units, but to undertake the hydro-electric plant construction. One of their chief difficulties, however, is that which was adumbrated by Professor Gibson, viz., the difficulty of obtaining British-born hydro-electric engineers. It would appear that this new departure presents a very favourable opportunity to the many who have taken up the study of water power in recent years, as a result of the greatly increased interest in the subject, to turn their acquired knowledge to good purpose, and to increase it further. Fellows of the Society may know of engineers who may be looking for such opportunities in the hydro-electric world, and a very useful purpose would be served if they would bring this matter to the notice of such individuals.

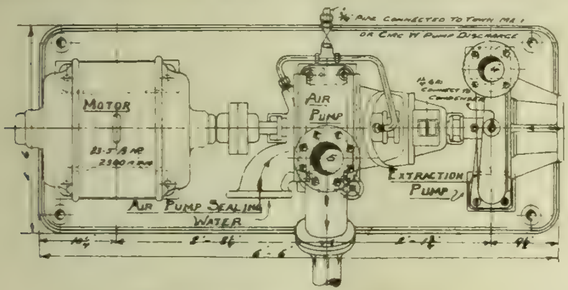
* "British Engineering and Water-power Development (The Training of Engineers)."

ENGINEERING LAY-OUT ARRANGEMENTS AND TENDER DRAWINGS.

By Douglas Wilson, A.M.I.Mech.E.

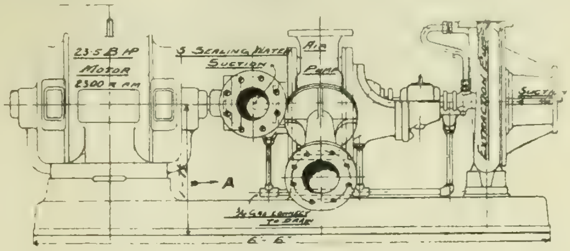
(*Continued from page 233.*)

A general arrangement of the air and extraction pumps is shown at Figs. 97, 98, and 99, one set of these pumps each belonging to Nos. 1 and 2 surface sets.



Engineering Lay-out.—Fig. 97.

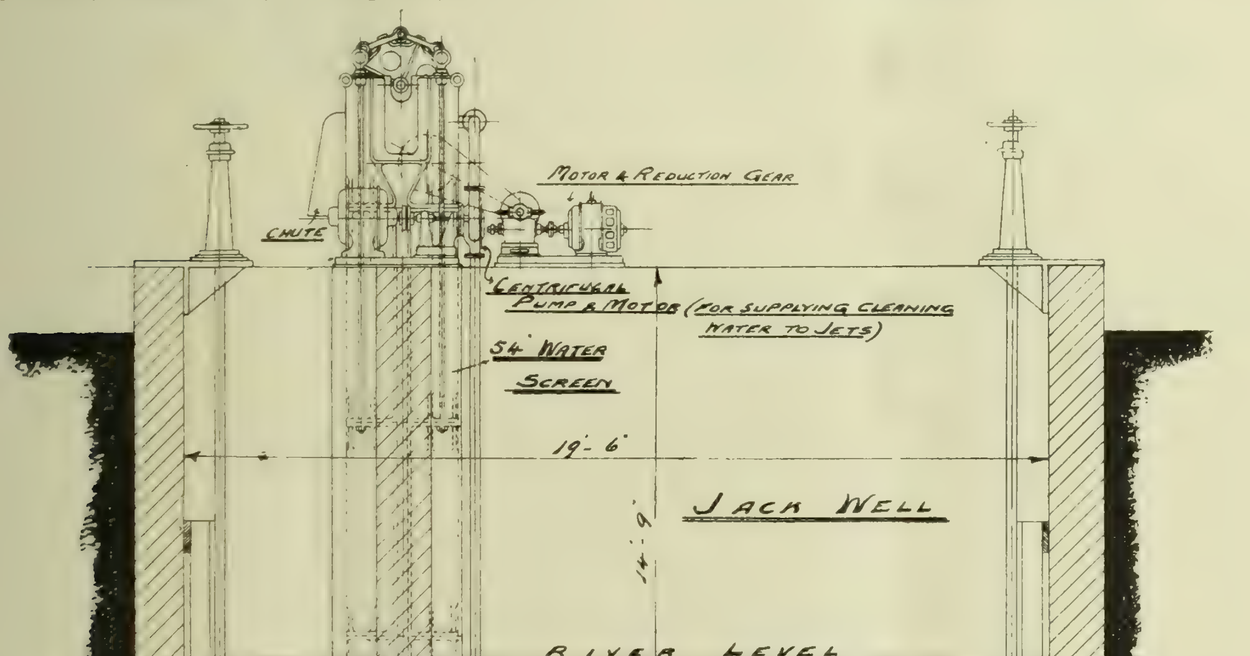
To prevent any foreign matter, such as mud, floating leaves, rubbish, etc., entering the jack well from the river, a self-cleaning circulating water screen was installed in the position shown, this being a very important adjunct to the installation, as the river, being so shallow, the bottom being nearly level with the basement floor, refuse, etc., might easily be sucked into the pumps, causing probably frequent trouble. The actual arrangement of screen installed is shown at Figs. 100 and 101, being respectively a plan and section of same in jack well, and the method of working is shown diagrammatically at Fig. 102,



Engineering Lay-out.—Fig. 98.

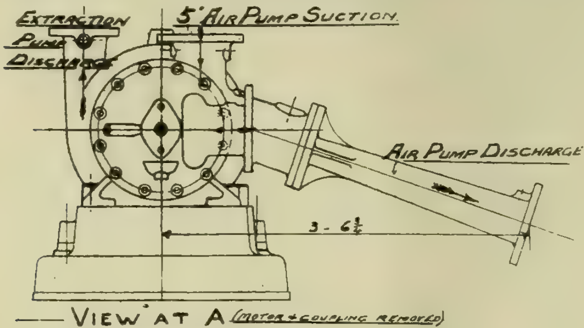
whilst a general view of the complete screen is illustrated at Fig. 103.

Referring to Fig. 102, the screen consists of a long frame A, which may either be in steel or cast iron, according to conditions. Between the sides of this frame a driving drum B is mounted at the upper end. An endless screening band D, consisting of per-



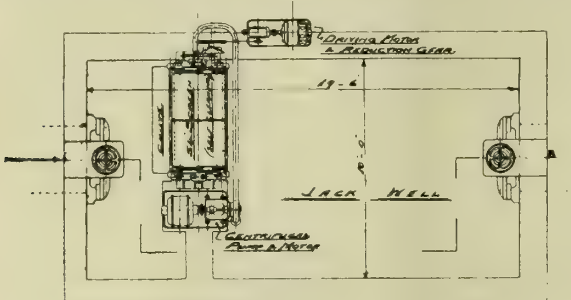
Engineering Lay-out.—Fig. 101.

forated meshes, passes round this drum, and is kept continually moving in one direction by the rotation of the drum B. The circulating water flowing



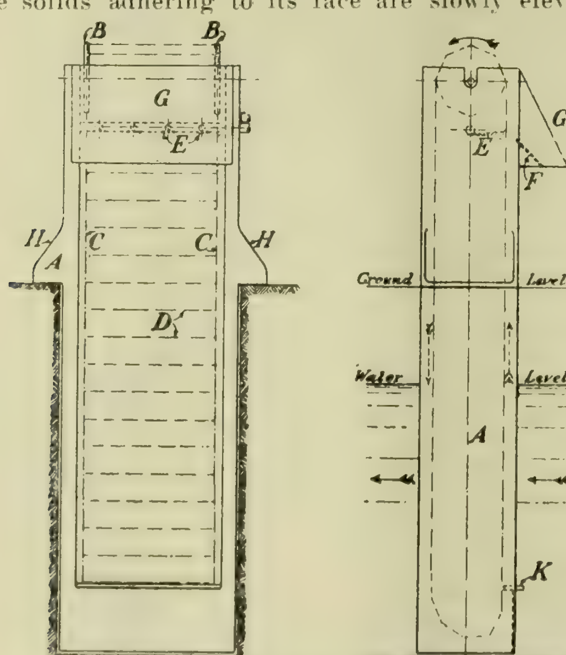
Engineering Lay-out.—Fig. 99.

through the screen first meets the rising side of the mesh, and deposits thereon the floating rubbish, leaves, etc., the cleansed water then passing to the



Engineering Lay-out.—Fig. 100

condensers and air pumps. In consequence of the continuous upward movement of the screening band, the solids adhering to its face are slowly elevated



Engineering Lay-out.—Fig. 102

out of the jack well, until they are washed off into a chute or bin by jets E of high-pressure water playing on the inside of the screen, and placed above the highest water level. The jets are on the side of the screen facing the incoming water, and the band after being cleansed passes downwards into the water again, and is turned upwards at the lower end of the screen by means of guide rails suitably arranged and bolted to the side of the screen frame.

The screen at Stalybridge under normal conditions

Engineering Lay-out.—Fig. 103.

is capable of screening 480,000 gallons of river water per hour, and was designed and erected by Messrs. F. W. Brackett and Co. Ltd., Colchester.

DEFECTS FOUND ON BOILER INSPECTION *

By R. H. Kenyon.*

Boilers require care and study, like all other engineering accessories, but while running machinery is visible, to ascertain the condition of a boiler, it must be shut down and thoroughly cleaned, but the cleaning is an unpleasant job, with the result that the evil day is often deferred. This inattention does not tend towards safety, as the dirt is a form of camouflage for corrosion and very seriously affects the economical working. External wasting often occurs at the front end plate of Lancashire boilers, and is frequently due to the practice, when cleaning fires, of leaving the clinkers in a heap near the end plate and slaking them with water before removing them to the ash heap. The water and gases from the hot ashes, containing sulphur, readily attacks the plate. The better plan is to draw the clinkers straight into iron barrows, and wheel them clear before slaking.

Leakage from overhead pipes, etc., or in the open from heavy rains. The damp will work under the brickwork and cause corrosion. This cannot be seen until the brickwork is removed, when the plates will often be found wasted away, due to above causes, also that of leaky joints. Corrosion often takes place at all cleaning and access doors, due to faulty joints, and in loco. and vertical-type boilers at the foundation ring, due to sediment. Corrosion of this description

* Summary of lecturette delivered before the Junior Institution of Engineers.

is due to carelessness on the part of those in charge. A more difficult form of wasting to deal with is known as smooth wasting, which occurs in furnaces and flues of all boilers under certain conditions. In appearance, plates, tubes, rivet-heads, etc., look normal, but an experienced man, on careful examination, will find that the edges of the plates at the seams are not as sharp as they ought to be, *i.e.*, they are rounded, and, according to the amount of round and visibility of the original caulking edge, he would make a very good estimate of the reduction that had taken place. In cases of doubt, drilling should be resorted to. This corrosion occurs mostly where a poor class of fuel, containing sulphur, is used.

Farm boilers and others that are used very intermittently give a lot of trouble, as their owners do not give them the required amount of attention.

In water-tube boilers, wasting often occurs at the cap seats, due to leaky joints; the steam issuing in a fine spray acts as a sand blast in conjunction with any fine deposit in the water. A similar action is noticed when fine particles of dust are carried by the draught through the tubes. This dust acts abrasively and reduces the thickness of the tube. This action also takes place in the smoke tubes of locomotives at the firebox and just inside the ferrule. Corrosion is sometimes found on the furnace plates at firebar level, in horizontal boilers, and is due to excessive sulphur in fuel. Furnace crowns often bulge, due to overheating and deposit of salts from the feed water or grease. In water-tube boilers this defect causes the tubes to bulge just over the fire. Internal corrosions occur in all classes of boilers, due to chemicals in the feed water, and this is accelerated by the mechanical action of " breathing " of the plates, caused by the temperature and pressure. The fire should be kept away from the door to relieve the strains on the end plates. In water-tube boilers, the old design of dished-end drum-heads, the radius and lap where the dished end joints the barrel was made too small, and the snap-head of the machine riveter cuts into the plate, causing a reduction of thickness and often causing a crack.

Longitudinal lap joints are not good, as the pressure tends to make the plate take up a truly circular form. If butt straps are used, the plates can be made more nearly circular and so avoid the strains otherwise set up. This defect has often caused severe explosions, especially in farm and similar types of boilers.

The stays of loco-type boilers often suffer from corrosion, due to deposit lodging on the stays, and is often a very serious nature.

Blue Bird Fans. A neat brochure has been recently issued by Messrs. W. G. C. Hayward & Co. Ltd., of Twickenham. It illustrates and gives details of a wide variety of the steam turbines made by the firm.

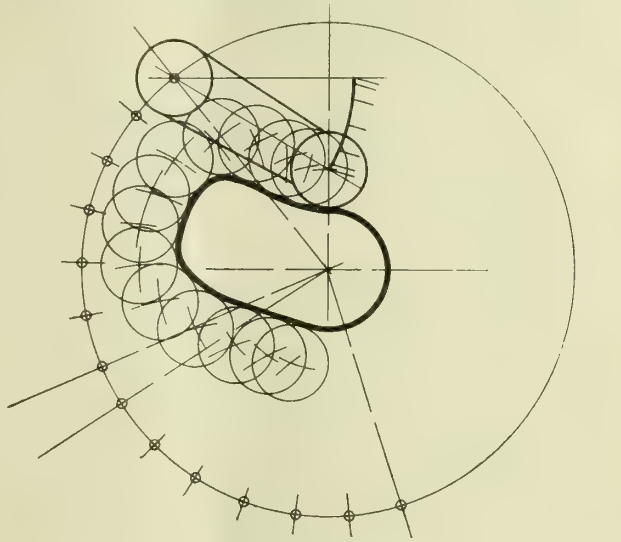
The knowledge of governors and of governing among both designing engineers and operating engineers is very incomplete. No special course in any engineering school is devoted to governors and governing, although in the design of all prime movers the governor plays so important a part. Mr. W. Trinks, Professor of Mechanical Engineering at the Carnegie Institute of Technology, has written a book, "Governors and the Governing of Prime Movers," which is intended to fill the gap. The volume, which should undoubtedly commend itself to students, designers, and draughtsmen, will be published immediately by Messrs. Constable and Co. Ltd.

CAMS.

By W. E. Bennison, A.M.I.M.E.

(Continued from page 328.)

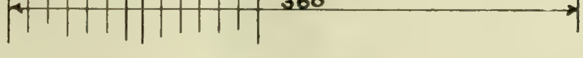
Fig. 53 gives a type of cam largely used in aeroplane engines. The lever is for operating one of the valves. Both forward and return stroke take 75 deg., and there is a rest of 10 deg. at the top of the stroke. The circular part of a cam which gives no



Cams.—Fig. 53.

motion to the follower is called a dwell. During the first half of each stroke the velocity is constantly accelerated, and during the second half constantly retarded: during the return the roller is pressed against the cam by means of a spring. The displacement curve is given by Fig. 54.

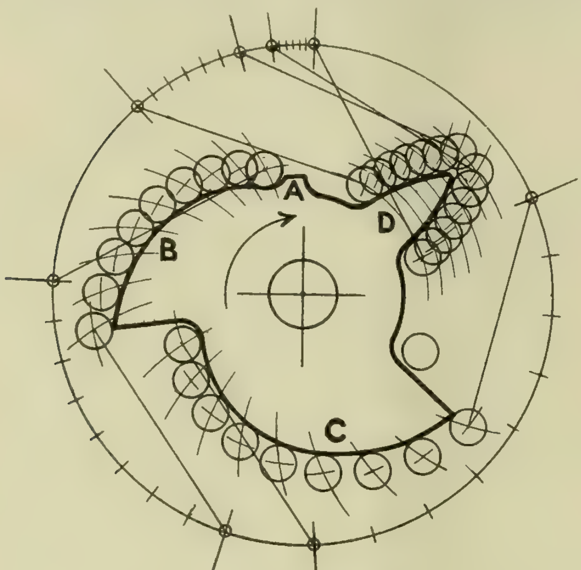
A very interesting cam is shown by Fig. 55. It is taken from a Brown and Sharpe automatic turning and screwing machine, and forms a very good illustration of a cam which gives several reciprocations to



Cams.—Fig. 54.

the follower. It is the cam which advances the turret slide. All the forward motions are with uniform velocity, and the return is made by means of a spring. Attention is called to Fig. 56, which gives the time-space curve for this cam, and illustrates exactly what the turret is doing at any time. First the stop must be slightly advanced to allow the stock to be fed against it, then a slight withdrawal during which the turret turns. The part marked A is for the feeding of the stock. Next a slow advance for the roughing cut is effected by the part marked B,

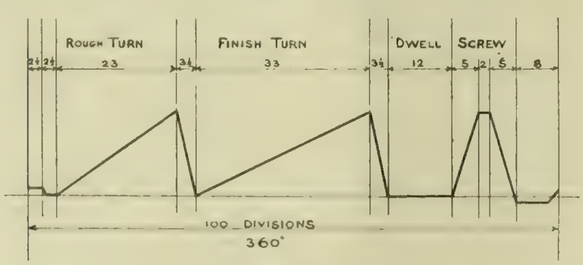
followed by a very quick return. The turret always turns during this quick return. The next movement is a still slower advance C for the finishing cut, followed by a dwell to permit of other operations by other slides. The projection D advances the die quickly for screwing. There is a slight dwell at the top to give time for the spindle to reverse, and then a quick return while the die unscrews. The last part of a cam is a dwell, during which the finished screw



Cams.—Fig. 55.

is parted off. In setting out these cams the circle is usually divided into 100 divisions.

Fig. 57 shows a special form of cam, which gives an approximation to harmonic motion. One complete revolution of the cam gives one reciprication of the roller. The cam curve is a circle whose centre is eccentric to the axis of rotation. It is really a form of eccentric. The motion of the roller is exactly the same as would be given by a crank whose length is equal to the eccentricity coupled to the roller by a connecting-rod of a length equal to the distance be-

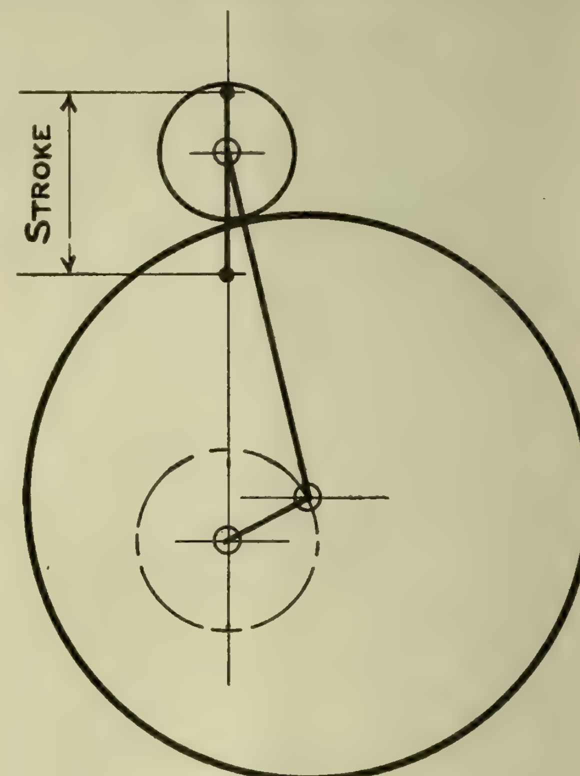


Cams.—Fig. 56.

tween the centre of the cam and the centre of the roller.

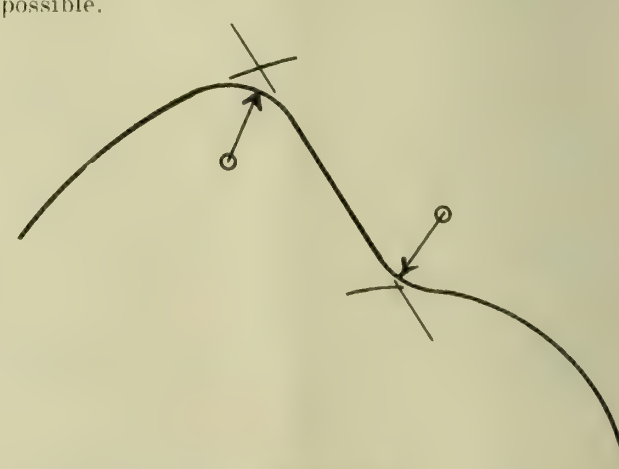
Hints on the Drawing of Cam Forms.

Most curves can be approximated to by arcs of circles. For a fairly short, flat curve one arc may suffice, but in general two or more will be required. There are few curves that cannot be represented by circular arcs, provided a sufficient number be taken. Care must be exercised that these arcs pass through all the required points, also that they join up nicely to form one continuous curve. The centres from which these arcs are struck must be very carefully marked, for it is upon their correct location that the accuracy of the cam in the concrete depends. Two dimensions will be required to fix these centres. One may be their radial distance from the axis of the cam,



Cams.—Fig. 57.

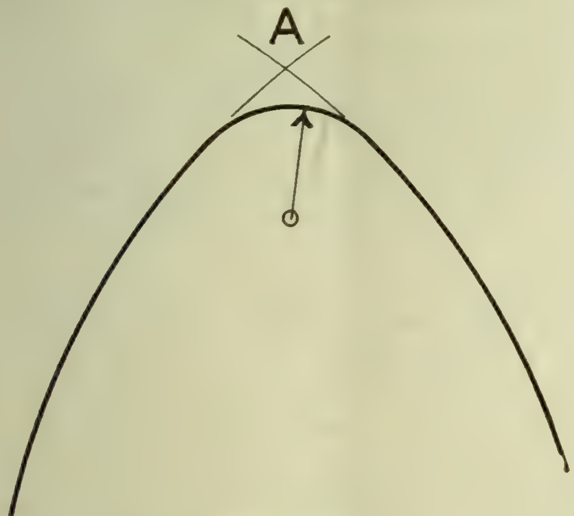
and the other should be from some reference line on the cam, such as the centre line of the keyway. The radii of the various arcs must also be carefully measured and marked down. If great accuracy is required it is best to calculate as many dimensions as possible.



Cams.—Fig. 58.

Where there are several parts to a cam, the various forms as a rule require to be joined up by a joining curve. Sharp corners should be avoided where possible; they cause shocks and tend to wear flats on the rollers; also they themselves are liable to exces-

sive wear, thus destroying the shape of the cam. Take the case of a dwell, followed by a steep rise, followed by another dwell at the top of the stroke, as shown in Fig. 58; or an advance followed almost immediately by a return, as in Fig. 59. Under these conditions the different curves should be joined up by arcs whenever possible, as shown in the figures. It will have been noticed that it is not always possible to use these joining curves; for instance, in Fig. 59, the follower might have to travel right up to the point A; in that case, the joining curve would have to be omitted or the shape of the cam modified.



Cams.—Fig. 59.

Data for Laying Out Cams.

The following data will have to be given or decided upon before the cam can be laid out:—

- The length of stroke of the follower.
- The shape of the follower path.
- The direction of motion of the follower.
- The diameter of the cam.
- The direction of the cam's rotation.
- The length of time (in angular motion of the cam) allowed for each movement of the follower.
- The kind of velocity to be given to the follower.
- The size and shape of the follower.

Most of these particulars will be governed by the conditions obtaining in the machine, of which the cam is a part; by the functions of other parts; and by the position of other parts. It is not possible to treat the cam like many other problems, where certain data are given, from which it is possible to calculate the desired particulars; on the contrary, unless the conditions are very simple, many of the factors will have to be modified to suit others, the result being a compromise.

The length of stroke of the follower may be fixed by the functions of the machine, and have been decided upon earlier in the design. If the follower is carried by a lever, the angular motion of the lever will have been fixed; the length of the lever, however, and consequently the length of stroke, may be made, within limits, to suit the other conditions.

The shape of the follower path and direction of motion of the follower depend upon the motion of the piece which carries the follower and its position with respect to the axis of the cam. This position should be fixed to give a good curve.

The diameter of the cam is usually a variable one, which allows of some scope. There will be a maximum diameter on account of the juxtaposition of other parts or the limitations of the machine. Within these limitations the diameter should be large, if great accuracy is required, or if the curve otherwise becomes too steep.

The direction of the cam's rotation may be controlled by other parts of the machine. For instance, it may be mounted upon a shaft, which also performs other functions. Where a free choice is allowable, it is best to make the direction such as suits the direction of the follower motion best. For instance, one direction will often give sweeter motion, or one direction may even tend to lock the mechanism. This will be dealt with more fully in the section on limiting conditions.

The angular movement of the cam allowed for the follower stroke should be fixed so as to obtain a free movement. A good wedge angle should be aimed at, and this, of course, depends upon the length of the cam angle combined with the stroke. If the camshaft is performing other operations the cam angle will be limited.

The kind of velocity to be given to the follower has been dealt with. This also depends upon the conditions, and judgment is required. The load, the velocity, and the steepness of the curve are all factors which enter into the problem.

The size and shape of the follower are determined by practical considerations and the nature of the work to be performed. The various types of followers have been dealt with previously, and that one will have to be selected which best suits the work in hand. As said before, the roller is the one most commonly adopted, and which is most suitable for the great majority of cases.

It has been said previously that the design of a cam, if at all complicated, is a matter of compromise. When designing a cam it is usually desirable to make a provisional drawing first to decide upon the cam angles, investigate the slopes of the curves, find out if there are any interferences, fix the joining curves, and make any modifications which may be necessary. The final layout can then easily be constructed.

(To be continued.)

Horizontal Steam Engines.—Messrs. Marshall, Sons & Co. Ltd., of Gainsborough, have sent us a circular relative to their Class "O" horizontal steam engines. The circular also contains illustrations and description of the firm's liquid fuel burning apparatus.

The *Caledon Welfare Magazine* is the name of a new works journal just issued by the Caledon Shipbuilding Co. The first number includes, among notices of the many social activities of the firm, an article on the ethics of sportsmanship, by Lieut.-Col. E. A. Berrisford, M.C., President of the Oxford University Boating Club, and a clever cartoon by Mr. Bert Thomas, caricaturing the suggestion that music might be introduced to accompany the more monotonous tasks in industry. There are other contributions on motor-cycling, athletics, allotments, the effect of mechanical inventions on the working man, boy-life in China, with two pages devoted specially to women. The magazine is well printed on good paper, amply illustrated, and neatly laid out, and is published on behalf of the Caledon Shipbuilding Co. by the Industrial Welfare Society.

COAL CONSERVATION IN THE UNITED KINGDOM.

Probably the most interesting lecture of the year was that delivered on April 20, before the Institution of Civil Engineers, by Sir Dugald Clerk, D.Sc. It was the "James Forrest" lecture for 1920, and was listened to by a large and appreciative audience. The subject was the conservation of our coal supplies, which is attracting the attention of every thoughtful man, not because of the immediate importance of the subject, but on account of the fact that there is a great deal of waste which must be eliminated in the future if we are to secure the maximum of power from the coal consumed.

Sir Dugald considers the conservation of coal to be a vital matter. Our present industrial civilisation depends upon our supplies of fuel and motive power, and without coal, oil, and motive power it would be impossible to support in comparative comfort our population of 46 millions. In his opening remarks the lecturer pointed out that the coal raised in 1913 was approximately 287·4 million tons, of which 189·1 million tons were retained and consumed in this country. The total coal reserves at 2 per cent per annum increase would be exhausted in about 250 years, but long before that time fuel would be so expensive that we would be hardly pressed to maintain the existing population. It was of the utmost importance, therefore, to study the engineering problems arising under the changed conditions.

Sir Dugald Clerk then showed how the coal consumption for 1913 was distributed, and he took his figures from the report of the Coal Conservation Committee, though these did not give any direct indication of either the total coal consumption for motive power purposes or the total horse power hours developed by the steam and other engines of the country. According to Professor Bone, the division of consumption for 1913 was approximately as follows:—Consumption in mines and factories, chiefly for power, 80 million tons; iron, steel and other metallurgical industries, 32 million tons; bricks, ceramics, glass and chemicals, 6 million tons; railways and coasting steamers, 17 million tons; gasworks, 19 million tons; domestic purposes, 35 million tons. That is to say, power, gasworks, and domestic use consume between them 134 million tons per annum, or about 71 per cent of the entire coal consumption of the United Kingdom. Referring to the Coal Conservation Committee's conclusions that 80 million tons of coal were consumed in 1917 for the production of power, including railways, whereas only 25 millions would be required if the whole of the existing steam engines in separate factories were replaced by a great general system of electrical generation and distribution, the lecturer said if this be true the super-stations would certainly justify their existence. He challenged this belief, and continued that the report assumed an approximate knowledge of four values:—

(1) The amount of coal used in the United Kingdom for the production of power only.

(2) The amount of mechanical or electrical energy produced from this coal and used in driving workshops, mills, factories, electrical generation, and railways by steam engines, reciprocating and turbine.

(3) Assumed consumption of coal per brake horse hour at present, calculated from 1 and 2.

(4) Possible reduction of total consumption of coal by the proposed super-stations.

Sir Dugald pointed out that at the time when the Conservation Committee issued its interim report—April, 1917—no data existed giving the average consumption of coal for electrical generation. The setting up of the Coal Control system secured the fuel and power data of the whole of the electricity supply undertakings of the United Kingdom utilising coal for the year ending March 31st, 1918. This showed 421 such undertakings which generated in the year 4,674 million Board of Trade units on an average consumption of 3·47 lb. of coal per Board of Trade electrical unit, or 2·59 lb. per electrical horse power hour. There they had accurate knowledge of the fuel consumption of at least 10 per cent of the whole power of the country.

The lecturer then proceeded to show the extent to which the textile trades were power consumers. He put their mean consumption fuel at 2·33 lb. per brake horse power hour. Results obtained with 100 typical colliery steam boiler plants were reviewed, the average here working out at 5·5 lb. of coal per brake horse power hour. Taking all the information available, Sir Dugald gave his estimate of the average coal consumption for steam power in the whole country as 4·05 lb. of coal per brake horse power hour.

The next section of the lecture was devoted to the effect of using electricity for generating heat on possible coal economy. The Committee appeared to intend the general economy of the improved efficiencies of the super-stations to include the supply of heat also, and they expected coal conservation to be further improved by this addition. To test this matter, it was desirable to consider first the question of heat supply by electricity and by coal gas. Examining the output from the projected super-stations, and comparing it with the production of the gas works now in existence, showed that the whole of the assumed saving on power would be lost, and 68·6 million tons of coal per annum would be consumed instead of 67·5 million tons. "In my opinion, on the facts which I have shown," said Sir Dugald, "the super-stations will not justify their existence. The Government scheme is wrong, and the sweeping conclusions arrived at by the Coal Conservation Committee are unjustifiable. In other words, there is no possiblity of saving 55 million tons per annum of the fuel of the country by carrying out the full scheme."

The whole trend of Sir Dugald's lecture was to show that in fuel economy the gas industry far surpassed the electrical industry on the average consumption of coal required for a general service of heat, light, and motive power. Great changes were in operation throughout the gas industry, due to the adoption of the thermal unit standard for sale, and the passing away of the intrinsic illumination standards so long adopted. These changes would allow of greatly improved thermal efficiencies of production and distribution. In a few years, the majority of gasworks would deliver to the consumer, in the form of gas, 75 per cent of the whole heat of the coal used, and the improvement in gas apparatus, construction and design, are so great that the efficiency of use of the gas will rise from 42 per cent to 55 per cent.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 84 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 2 0	0 15 0 0	1 2 2 0	1 10 0 0	1 17 2 0	2 5 0 0	2 12 2 0	3 0 0 0	3 7 2 0	0
1	0 3 0	8 1 0	0 15 3 0	1 3 1 0	1 10 3 0	1 18 1 0	2 5 3 0	2 13 1 0	3 0 3 0	3 8 1 0	1
2	1 2 0	9 0 0	0 16 2 0	1 4 0 0	1 11 2 0	1 19 0 0	2 6 2 0	2 14 0 0	3 1 2 0	3 9 0 0	2
3	2 1 0	9 3 0	0 17 1 0	1 4 3 0	1 12 1 0	1 19 3 0	2 7 1 0	2 14 3 0	3 2 1 0	3 9 3 0	3
4	3 0 0	10 2 0	0 18 0 0	1 5 2 0	1 13 0 0	2 0 2 0	2 8 0 0	2 15 2 0	3 3 0 0	3 10 2 0	4
5	3 3 0	11 1 0	0 18 3 0	1 6 1 0	1 13 3 0	2 1 1 0	2 8 3 0	2 16 1 0	3 3 3 0	3 11 1 0	5
6	4 2 0	12 0 0	0 19 2 0	1 7 0 0	1 14 2 0	2 2 0 0	2 9 2 0	2 17 0 0	3 4 2 0	3 12 0 0	6
7	5 1 0	12 3 0	1 0 1 0	1 7 3 0	1 15 1 0	2 2 3 0	2 10 1 0	2 17 3 0	3 5 1 0	3 12 3 0	7
8	6 0 0	13 2 0	1 1 0 0	1 8 2 0	1 16 0 0	2 3 2 0	2 11 0 0	2 18 2 0	3 6 0 0	3 13 2 0	8
9	6 3 0	14 1 0	1 1 3 0	1 9 1 0	1 16 3 0	2 4 1 0	2 11 3 0	2 19 1 0	3 6 3 0	3 14 1 0	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7	14	21	1 0	1 7	1 14	1 21	2 0	2 7	2 14	2 21	3 0	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 84 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	3 15 0 0	7 10 0 0	11 5 0 0	15 0 0 0	18 15 0 0	22 10 0 0	26 5 0 0	30 0 0 0	33 15 0 0	0
10	0 7 2 0	4 2 2 0	7 17 2 0	11 12 2 0	15 7 2 0	19 2 2 0	22 17 2 0	26 12 2 0	30 7 2 0	34 2 2 0	10
20	0 15 0 0	4 10 0 0	8 5 0 0	12 0 0 0	15 15 1 0	19 10 0 0	23 5 0 0	27 0 0 0	30 15 0 0	34 10 0 0	20
30	1 2 2 0	4 17 2 0	8 12 2 0	12 7 2 0	16 2 3 0	19 17 2 0	23 12 2 0	27 7 2 0	31 2 2 0	34 17 2 0	30
40	1 10 0 0	5 5 0 0	9 0 0 0	12 15 0 0	16 10 1 0	20 5 0 0	24 0 0 0	27 15 0 0	31 10 0 0	35 5 0 0	40
50	1 17 2 0	5 12 2 0	9 7 2 0	13 2 2 0	16 17 3 0	20 12 2 0	24 7 2 0	28 2 2 0	31 17 2 0	35 12 2 0	50
60	2 5 0 0	6 0 0 0	9 15 0 0	13 10 0 0	17 5 1 0	21 0 0 0	24 15 0 0	28 10 0 0	32 5 0 0	36 0 0 0	60
70	2 12 2 0	6 7 2 0	10 2 2 0	13 17 2 0	17 12 3 0	21 7 2 0	25 2 2 0	28 17 2 0	32 12 2 0	36 7 2 0	70
80	3 0 0 0	6 15 0 0	10 10 0 0	14 5 0 0	18 0 1 0	21 15 0 0	25 10 0 0	29 5 0 0	33 0 0 0	36 15 0 0	80
90	3 7 2 0	7 2 2 0	10 17 2 0	14 12 2 0	18 7 3 0	22 2 2 0	25 17 2 0	29 12 2 0	33 7 2 0	37 2 2 0	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	37 10 0 0	75 0 0 0	112 10 0 0	150 0 0 0	187 10 0 0	225 0 0 0	262 10 0 0	300 0 0 0	337 10 0 0	375 0 0 0	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 83 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 1 18	0 14 3 8	1 2 0 26	1 9 2 16	1 17 0 6	2 4 1 24	2 11 3 14	2 19 1 4	3 6 2 22	0
1	0 2 27	8 0 17	0 15 2 7	1 2 3 25	1 10 1 15	1 17 3 5	2 5 0 23	2 12 2 13	3 0 0 3	3 7 1 21	1
2	1 1 26	8 3 16	0 16 1 6	1 3 2 24	1 11 0 14	1 18 2 4	2 5 3 22	2 13 1 12	3 0 3 2	3 8 0 20	2
3	2 0 25	9 2 15	0 17 0 5	1 4 1 23	1 11 3 13	1 19 1 3	2 6 2 21	2 14 0 11	3 1 2 1	3 8 3 19	3
4	2 3 24	10 1 14	0 17 3 4	1 5 0 22	1 12 2 12	2 0 0 2	2 7 1 20	2 14 3 10	3 2 1 0	3 9 2 18	4
5	3 2 23	11 0 13	0 18 2 3	1 5 3 21	1 13 1 11	2 0 3 1	2 8 0 19	2 15 2 9	3 2 3 27	3 10 1 17	5
6	4 1 22	11 3 12	0 19 1 2	1 6 2 20	1 14 0 10	2 1 2 0	2 8 3 18	2 16 1 8	3 3 2 26	3 11 0 16	6
7	5 0 21	12 2 11	1 0 0 1	1 7 1 19	1 14 3 9	2 2 0 27	2 9 2 17	2 17 0 7	3 4 1 25	3 11 3 15	7
8	5 3 20	13 1 10	1 0 3 0	1 8 0 18	1 15 2 8	2 2 3 26	2 10 1 16	2 17 3 6	3 5 0 24	3 12 2 14	8
9	6 2 19	14 0 9	1 1 1 27	1 8 3 17	1 16 1 7	2 3 2 25	2 11 0 15	2 18 2 5	3 5 3 23	3 13 1 13	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	6·91	13·83	20·75	27·66	1 6·58	1 13·5	1 20·41	1 27·33	2 6·25	2 13·17	2 20·08	2 27	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 83 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs	t. c. q. lbs.	t. c. q lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 14 0 12	7 8 0 24	11 2 1 8	14 16 1 20	18 10 2 4	22 4 2 16	25 18 3 0	29 12 3 12	33 6 3 24	0
10	0 7 1 18	4 1 2 2	7 15 2 14	11 9 2 26	15 3 3 10	18 17 3 22	22 12 0 6	26 6 0 18	30 0 1 2	33 14 1 14	10
20	0 14 3 8	4 8 3 20	8 3 0 4	11 17 0 16	15 11 1 0	19 5 1 12	22 19 1 24	26 13 2 8	30 7 2 20	34 1 3 4	20
30	1 2 0 26	4 16 1 10	8 10 1 22	12 4 2 6	15 18 2 18	19 12 3 2	23 6 3 14	27 0 3 26	30 15 0 10	34 9 0 22	30
40	1 9 2 16	5 3 3 0	8 17 3 12	12 11 3 24	16 6 0 8	20 0 0 20	23 14 1 4	27 8 1 16	31 2 2 0	34 16 2 12	40
50	1 17 0 6	5 11 0 18	9 5 1 2	12 19 1 14	16 13 1 26	20 7 2 10	24 1 2 22	27 15 3 6	31 9 3 18	35 4 0 2	50
60	2 4 1 24	5 18 2 8	9 12 2 20	13 6 3 4	17 0 3 16	20 15 0 0	24 9 0 12	28 3 0 24	31 17 1 8	35 11 1 20	60
70	2 11 3 14	6 5 3 26	10 0 0 10	13 14 0 22	17 8 1 6	21 2 1 18	24 16 2 2	28 10 2 14	32 4 2 26	35 18 3 10	70
80	2 19 1 4	6 13 1 16	10 7 2 0	14 1 2 12	17 15 2 24	21 9 3 8	25 3 3 20	28 18 0 4	32 12 0 16	36 6 1 0	80
90	3 6 2 22	7 0 3 6	10 14 3 18	14 9 0 2	18 3 0 14	21 17 0 26	25 11 1 10	29 5 1 22	32 19 2 6	36 13 2 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	37 1 0 8	74 2 0 16	111 3 0 24	148 4 1 4	185 5 1 12	222 6 1 20	259 7 2 0	296 8 2 8	333 9 2 16	370 10 2 24	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

As a concluding note the lecturer gave it as his view that in the next 10 years we may expect the general power consumption of coal to fall from 4 lb. per brake horse power hour to under 2 lb. per brake horse power hour, not by the extension of electric generation and use only, but by that extension as one element combined with the increased application of economical internal combustion engines, and the improvement in steam boiler and town gas, and gas producer efficiency.

ELECTRIFICATION OF HOLLAND.

A National Scheme.

One of Holland's greatest difficulties as an industrial country has been the high cost and consumption of coal in all her industrial undertakings. This it is now proposed to remedy by an extensive scheme of electrification, embracing practically the whole country.

A network of high tension transmission lines has been planned, as may be seen by reference to the map accompanying this article, and it is hoped that in due course Dutch industries shall enjoy the advantages of cheap power in order to be more favourably placed for export purposes against more fortunate competitors. In any case, it is considered that great economies will be affected by concentrating the various electricity supply undertakings into a national scheme which, at the same time, will be useful to develop the smaller manufactories all over the country.

The Proposed High Tension Transmission Lines.

The scheme, as at present estimated, is to cost 125,000,000 florins, and it is understood that as Dutch manufacturers are not in a position to tender for all the plant required, a fair proportion of this will be placed abroad. Already orders amounting to over £1,000,000 have been secured in this country.

Electrical Power Estimates.

There are, of course, several companies in Holland supplying electrical power, etc., in various localities. Their activities, under the new scheme, will be allied to those of the State—the former being charged with the 10,000 volt, and the latter undertaking the 50,000 volt distribution. As to the terms under which the State obtains control of existing interests, we are not at present concerned, but the scheme itself contains several points of interest to technical readers not only on account of its scope, but in view of the difficulties which have to be surmounted in a country such as Holland, which lacks any assistance from water-power.

The following table illustrates the very considerable increase that has taken place in the consumption of electrical power, etc., in Holland since 1913:—

	Maximum load on the electrical power stations. Kw.	Total consumption per annum. Kwh.
1913	45,600	114,000,000
1914	53,600	134,000,000
1915	69,600	173,000,000
1916	88,400	221,000,000
1917	90,000	216,000,000
1918	100,000	240,000,000

To meet present requirements the Government Committee reporting on the question under the present scheme is of opinion that it is necessary to arrange for a total load on the electrical power stations of 3-4,000,000 kw., giving a total capacity of 1,000,000,000 kwh. per annum. Such a supply will mean, with an anticipated population of 10,000,000 inhabitants in the next 30 years, a consumption of 100 kwh. per head per annum, as against 35-50 at present. This will compare with a present approximate consumption in the United States of America of 176 kwh. per head, 140 for Switzerland, 60 for England, 50 for Germany. This estimate does not take into account the electrification of railways and the replacing of all steam traction by electric traction, for which it is provisionally estimated that 250,000 kw. will be necessary, although not more than one-third or one-quarter of this amount will be required for the next 15 years.

Immediate Developments.

As to the execution of the project, the construction of the transmission lines for the whole country may take from five to 10 years. For the high-tension network three-phase current, 50 cycles is to be adopted, the minimum voltage being 50,000. The capacity recommended for the power-stations supplying the system is approximately 30,000-75-000 kw. Each station will be equipped with generators developing 15,000 kw. As the first step in the scheme, certain legislation is necessary to empower the Government to take over, as stated above, those electrical supply undertakings which are necessary for incorporation in the scheme. These are:—

(1) The power station Geertruidenberg, with the 50,000 volt lines in the Province of North Brabant belonging to that power station.

(2) The recently built power station of the municipality of Amsterdam.

It is also recommended that the construction of high-tension lines should commence immediately as under:—

(1) Roosendaal-Flushing or Middelburg.

(2) Helmond or Uden—South Limburg.
(2) Geertruidenberg - Rotterdam - The Hague - Amsterdam, with a branch line to Utrecht.
(4) Uden-Nymegen-Arnhem-Zwolle.

The cost of the above is estimated at 35,000,000 to 40,000,000 florins.

Organisation.

As far as is known at present, a special Administration is to be created for this service. Several alternatives have been under consideration, particularly a proposal under which the State would hold a large block of shares in a company registered for the purpose. Preference has been given to a State enterprise under which the supply of electricity is to be a direct Governmental service endowed with a large measure of freedom. Working agreements will be made as to the supply of current and the sharing of profits with municipal and other companies administrating the scheme.

Technical Aspects.

A Committee, formed by the Society of Directors of Electricity Supply Undertakings in Holland, has been investigating this proposal for some time past, and is to publish a report in 11 parts, four of which have been issued up to the time of writing.

High Tension Transformer Stations.

The first deals with the question of determining the positions of the high tension transformer stations. The Committee has calculated that for loads of 7 kw. to 20 kw. per km. area, the feeding of the 10,000 volt cables with 50,000 as well as with 100,000 volts will be secured in the most economical way if the transformer stations are 20 to 30 km. apart.

In order to apply this general calculation to Dutch conditions, the question was put before the directors of the several electricty works, asking them which places in their district would be most suitable for the erection of transformer stations. It appears that about 50 transformer stations will be necessary for the country, and they will be an average distance of 25 km. apart.

Feeding of the Transformer Stations.

In the second, the feeding of the high tension transformer stations (determining the tensions, area of wires, etc.), is reported on. The average distance of the feeding points of the 10,000 volt distribution cables having been fixed, there remains the question of tension and the cross-section of the high tension lines, which have to feed the 50 transformer stations. The calculations are based upon the supposition that the transformer stations are situated at regular distances of 25 km., and that they are all equally loaded. The results of these calculations are shown in graphs, added to the report, thus indicating the tension and sectional area of the lines.

These graphs also show that for large but sparsely populated districts a very high voltage is most economical, whereas for heavily-loaded industrial centres a lower voltage is to be preferred. It is furthermore evident from this report that the concentration of the generation of electricty has its limits, and it will be preferable, above a certain amount of power (*e.g.*, 30 to 50,000 kw.), to erect more power plants instead of making a heavier high tension distribution system.

So the second part of the report gives an idea not only of the tensions and cross-sections of wire, but to a certain extent also of the number of power plants wanted.

The third report deals with the scheme from the point of view of national defence. This does not concern us.

Transmission of Energy from South Limburg.

In the last, however, the transmission of electrical energy from the mining district is outlined. It is here stated that in addition to feeding the transformer stations the high tension lines should also be capable of performing other functions. They should, for example, be able to transmit energy in the shape of electricity from places where, for some reason or other, the costs of generating electricity are very low. The question of feeding a part of the network from the South Limburg mining district is then specifically examined.

The conclusion arrived at is that it is much more profitable to transport the fuel, unless the effective value of this fuel is less than one quarter of the effective value of coal of ordinary good quality.

Supplying a part of the country with electricity from the mining district will, therefore, only be justified if there is a very inferior fuel (brown coal and minestones) in sufficient quantity at hand. The Committee find that there is no more inferior fuel present in the South Limburg mining district than can be consumed by the mines in their own power plants, and so they conclude that there is no urgent need to build a transmission line for connecting the South Limburg mining district to the other part of the network.

Finally, the report states that the advantages of centralisation are greater than those attainable by the use of inferior fuel. Accordingly, there should be advantages in placing the whole generating for the mining district under one authority with one or more large power stations. It should then be able to compete in the electricity supply of the southern part of the country. This power plant would afterwards profit from the same advantages which are to be had from the use of inferior fuel, when the output of that inferior fuel will have increased. The mining industries themselves will require large quantities of electricity, and it will be advantageous to concentrate the production in one or more large power plants, instead of dividing the production over a number of smaller plants.—*Board of Trade Journal.*

DESIGN AND APPLICATIONS OF "HIGH-SPEED GEARING."

By M. Coronel.

(*Continued from page 337.*)

Both shafts are held between the bearings on one side, generally the side on which the end of the slow-speed shaft protrudes, and allowed to expand towards the other bearings.

The pedestals are cast solid with the casing, the caps being independent. The bearings are usually of cast iron, but for large powers cast steel is used. The bearings are lined with white metal, and it has been found that these bearings give better results when, after being cast in, the white metal is hammered into place and its surface hardened through this process before being finish-turned in the lathe. It ensures density of metal and increases considerably the hardness of the wearing surface.

The top casing is either made in one piece or in three pieces, split vertically, one over the gear, one each over the bearings, but quite independent of the latter, or with each having its separate cap.

The bearings are fed by forced lubrication under a pressure of about 5 lb. per square inch, and the collected oil is run off

through the bearing housing, in which thermometer pockets are provided to test the temperature of the off-running oil. The oil pump is driven from the end of the slow-speed shaft through a positive drive, viz., gearing of some kind, generally screw, worm, or bevel gearing, the drive being vertically under the shaft; the pump is at or below the floor level, as these pumps have no great capacity of suction lift. They run at about 450 revolutions per minute, delivering about 5 to 10 gallons per minute according to the size of gear. These pumps have an efficiency of about 70 per cent of the theoretical volume displaced. The oil runs from the bearing housings into a tank situated under the bedplate, of a capacity of about 150 to 200 gallons. From this tank the oil pump sucks its supply, and it is advisable to build the pump about the oil level in the tank and not to give any suction lift. The tank is filled to about two-thirds its capacity with oil. From the pump the oil is forced through a strainer, which should be so arranged that it can be cleaned out and replaced while are screwed in pairs, or several together in a common holder, according to the width of the gears. These gears are made in three types, one where the single helices are only separated by a narrow space 1 in. to $1\frac{1}{2}$ in. wide to allow for the hob to pass out, the wheel and pinion otherwise being each built in one width; secondly, where the two parts of the large wheel are quite separately keyed on the shaft; the third method, where the wheel consists of a centre keyed on the shaft on which are shrunk two cost or wrought-steel rims spaced sufficiently apart to allow room for the centre bearing of the pinion shaft. The two latter types are shown in Figs. 9 and 10. In the case of Fig. 9 two disc type forged steel wheels are keyed on a taper end of the shaft, cone taper 1 in 10 in diameter, and secured by keys and a nut. In the third case a cast-iron or cast-steel centre is keyed on a parallel enlarged part of the shaft, and wrought-steel rims are shrunk on and pegged to the centre, each rim with a helix of opposite hand to the other. The helix angle is between

TABLE V.

	Single Reduction Gears.										Double Reduction Gears.					
Driving.	Generator.	Generator.	Mill.	Mill.	Generator.	Fan.	Mill.	Fan.					Fan.	Fan.	Generator.	Generator.
B.H.P.	750	800	2,000	2,000	750	600	1.500	1,000	100	450	450	..	400	..	200	..
R.P.M.	3.000	3,000	3,000	3,000	3,600	3.600	3,000	3,000	4,800	3,000	4,000	..	3,200	..	3,200	..
R.P.M.	750	400	300	300	750	400	428	1,900	1,750	1,000	120	..	160	..	230	..
Reduction	4	7·5	10	10	4·8	9	7	1 58	2·75	3	33·5	4·6 7·2	20	3·21 6·45	14·1	3·3 4·2
Centres, ins.	18·571	27·857	50·0	42·0	18·85	27·27	29·71	14·0	6·714	11·95	20	24	20	..	12	..
Diam. pinion, ins.	7·83	6·55	9·1	7·66	6·5	5·45	7 4	10·85	3 58	5·974	4·9	18·55	5·38	9·5	4·5	5·75
Diam. wheel, ins.	31·21	49·16	91·0	76·3	31·25	29	52	17·15	9·85	17·922	35·2	39·4	34·63	30·5	19·5	18·25
Face width, ins.	13	18	40	34	14	15	23	13·5	7	13	9	20	11	20	6	13
No. of Teeth—																
Pinion	..	..	..	23	..	..	..	..	..	..	35	44	..	..	20	15
Wheel	..	..	..	229	..	..	..	..	..	..	251	202	..	..	87	44
Pitch Teeth	..	..	..	1in.	...	..	..	..	..	..	·44	·61	..	..	·7	1·65
Circl. speed, ft. per min.	6,100	5,150	7,200	6.000	6,150	3,030	5,800	9,300	4,500	4,700	5.130	1,240	4,500	1,250	3.750	1,140
Tooth pressure	4,050	5,150	9,200	11,000	4.020	6,500	8,550	3,550	730	3,160	2,900	12,000	2,950	10 650	1,430	6,000
Tooth pressure per 1 in. face.	310	285	230	325	288	433	370	263	104	243	324	600	295	560	237	463
					13,100	10,500	31,600	21,000	1,310	9,400	..	..	..	..	..	..
Torque, inch-lbs.	15,800	16,800	42,000	42,000	63,000	94,500	220 000	33,000	3,650	28,400	7,100	2,360,000	7,900	..	3,940	16,600
Bearings—																
Pinion, ins.	..	..	..	..	4·75×10	4·5×10	..	..	..	4·25×8	2·5×7	..	3·75	..	2·5×7·5	3×8
Wheel, ins.	..	..	..	..	5·5×9	6·25×10	8·4×14	..	..	4·25×8	7×13·5	7×13·5	6·75	.	4×9	3×8
Pressure, lbs. per sq. in.	..	..	..	..	43·5 41·8	74·5 54	41 & 53 72	.. ..	.. ..	46·5 46·5	85·5 65·5	81·3	..	..	38	125
Surface speed, ft.-min.	..	..	..	..	4.500 1,080	4,230 655	4,700 950	.. ..	.. ..	3,350 1,117	3,660 220	1,020	..	..	2,100	240
Stress, lbs. per sq. in.	..	..	..	..	615 1,900	585 1,970	745 1,830	.. ..	.. ..	625 1,900	2,300 3.500	..	..	..	1,285	3,120

running. From there the oil passes through an oil cooler of ample capacity of the usual surface condenser type, with brass tubes fastened in end plates. The oil passes outside the tubes, the cooling water inside the latter. The oil passes then through a check valve, and from there to a distributor on the gear frame or bed, whence the oil is distributed to the various bearings and spray nozzles for the gear. The gears themselves are sprayed over their entire working width on the in-running side, which should preferably be on the underneath side of the gear, thus giving a downward bearing pressure, and puts no strain on the cap bolts. The quantity of oil required is about one gallon per minute per 100 to 150 H.P.

Oil level and pressure gauges are provided on inlet and delivery side of the cooler, also an oil relief valve on the delivery side of the pump. Test cocks, with dishes, are provided, to show whether the oil is circulating freely to the bearings, and sight feed oil funnels for continuous control of same. The spraying nozzles are usually of a design, as shown in Figs. 5 and 6, and 25 deg. and 30 deg. The wheel bearings are fixed in their pedestals, but the pinion bearings are adjustable in the direction of the wheel with filling plates and justable liners, so as to adjust the wheel and pinion centres distance accurately, and make the gear run noiselessly, even at high speeds. These gears are made, in case one, without a centre bearing for the pinion shaft; but for high powers and speeds this method has not been found satisfactory.

Oil throwers and oil scrapers are arranged on the driven and driving shaft ends to retain the oil in the casings.

Finally, a ventilator is fitted for precipitating and carrying off the oil vapour which gathers in the gear case due to the churning up and the spraying of the oil. This vapour is so finely divided that it is highly inflammable, and a naked light brought near the casing would cause an explosion. A danger plate to such effect is therefore attached to a prominent part of the casing. (See Fig. 1.)

These gears have a very high efficiency, and are guaranteed by the makers to give a 98 per cent overall efficiency. A few particulars of sizes, pressures, and speeds of double reducing gears of this kind are given in Table V. to show present practice. From the table it will be seen that the pressure on the bearings, due to torque only, is about 50 lbs. to 75 lb. per square inch projected area. The surface speed of shaft in the bearings is about 4,000 ft. to 5,000 ft. per minute. The maximum stress due to torque only in the shaft occurs at the bearing section, and is about 4,000 lb. to 5,000 lb. per square inch.

Peripheral speed of pitch line is 4,000 ft. to 6,000 ft. per minute, and the tooth pressure per inch of width is 250 lb. to 350 lb.

These gears are cut with very fine pitches (one-half and sometimes ·40 circular pitch for small pinions) even for high powers, so that several teeth mesh and bear load at the same time, thus ensuring very smooth running. The minimum number of teeth in the pinion is 19, but 22 to 25 is preferable.

In the attempt to neutralise the side pressure on these double helical gears, due to the spiral angle, Mr. McAlpine, of the American Westinghouse Co., in about 1907 patented and introduced a reducing gear in which the pinion shaft is carried on a rocking cradle with the object of distributing the load equally between the two helices of the gear. The arrangement is, however, clumsy, and has not found much favour generally.

One such a gear transmitting 6,000 B.H.P. has a pitch line velocity of 5,500 ft. The floating frame which enables the teeth to take an equal load over the whole width. The teeth have a pitch of $1\frac{1}{4}$ in. and a face width of 40 in.

The following are particulars of another set, which transmits 2,650 B.H.P. maximum.

Diameter of opinion, $6\frac{5}{8}$ in. Diameter of wheel, $33\frac{3}{4}$ in.

Teeth in pinion, 23. Teeth in wheel, 115.

Face width, $26\frac{1}{2}$ in.; pitch, ·92 in.; pitch line velocity, 6,600 ft. per minute.

Centres of gears, $20\frac{1}{4}$ in.; load pr inch wide of teeth, 404 lb.

Revolutions of pinion, 3,750 per minute. Revolutions of wheel, 750 per minute.

Ratio of gear, 1 : 5. Helical angle, 30 deg.

British practice in turbine gears seems to recognise a maximum pitch of $\frac{7}{8}$ in. Pinions with ·815 in. pitch have transmitted as much as 10,000 H.P. at a pitch line velocity of 6,000 ft. to 7,000 ft. per minute. The pressure on the teeth per inch of width may be as much as 700 lb. to 800 lb., depending on size and tooth speed of pinion, with pressure angles up to $28\frac{1}{2}$ deg., but these are extremes, and not common practice, for which see Table V.

DOUBLE REDUCING GEARS.

The general design of these can be clearly seen from Fig. 11. The high speed shaft carrying a pinion with double helical teeth drives a wheel keyed on the conical part of a shaft; this shaft is continued, and carries the second motion pinion, which also is double helical, and is, in this design, made in two parts, one-half cut out of the solid shaft, the other half keyed on. This allows the pinion to be made a minimum overall width. If the pinion was solid with the shaft, a clearance space for the hob would be necessary between the helices. The second reduction wheel is made in halves, bolted together as shown, for the same reason as given above. The fittings and oiling arrangement are similar to those already described under the heading "Single Gears." These gears are used for reduction ratios ranging from 1 : 7 to 1 : 40. A few examples of sizes, speeds, etc., are given in table.

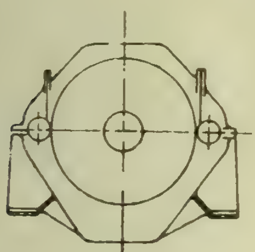


FIG 12

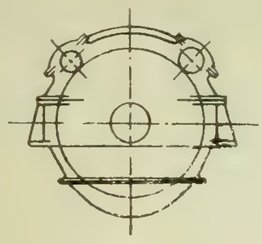


FIG 13

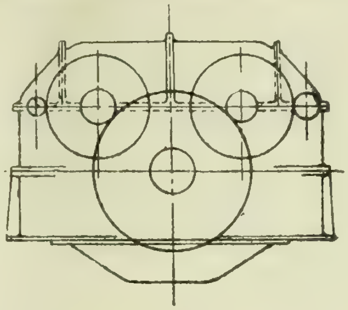


FIG 16

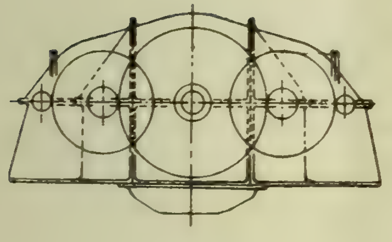


FIG 14

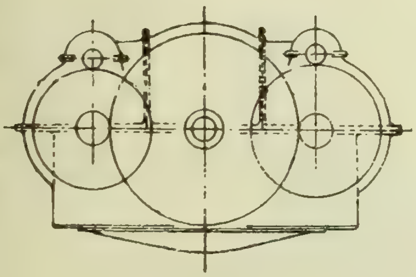


FIG 15

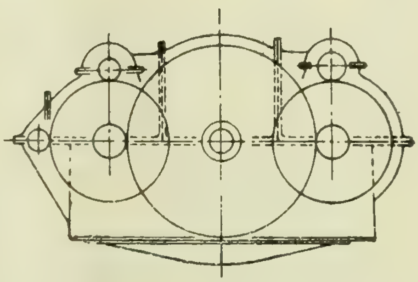


FIG 17

(To be continued.)

PETROLEUM RESOURCES IN CZECHO-SLOVAKIA.

Petroleum is found in Czecho-Slovakia in two regions adjoining the Carpathians, on the east in Slovakia, and on the west in Moravia. In the latter province traces of petroleum have been found in many places, particularly, at Ratiskovice, near the town of Hodonin, and at Bohuslavice, on the Vlara River. The oil fields of Slovakia are undoubtedly large, but have not been investigated sufficiently to permit of reliable estimates.

A memorandum prepared by the Research Division of the United States Bureau of Foreign and Domestic Commerce gives the following facts about the industry and its possibilities:—

BORINGS.

In Slovakia drilling for petroleum is a State monopoly. The principal wells are to be found near Gbely (in Magyar, Egbeli), a small town of 3,000 Slovak inhabitants, on the Kuty-Holic railway line, in the county of Skalice, district of Nitra. This territory formerly was under Magyar domination. When it was taken over by Czecho-Slovak Republic at the beginning of 1919, Well No. 68 was about to be completed, while the installation of three other wells was unfinished. At the end of 1919, well No. 82 was being bored and three other wells were being installed, showing that considerable work had been done in 1919, notwithstanding the unfavourable conditions. The Gbely wells yield a heavy oil which is employed as a lubricant, and has replaced the so-called "vulcan" lubricating oil formerly imported from Galicia.

For the present the borings are confined to the Sarmatian strata (the uppermost stage of Miocene formations). The wells are about 200 feet apart, averaging about 835 feet in depth. The Sarmatian oil is heavy, having a specific gravity of 0·930. The older Oligocene strata of the Tertiary formations have not been tapped as yet. A comparison with the Galician fields

shows that the fields of Slovakia have not been explored sufficiently, for in Galicia the borings are only 130 feet apart, and the wells reach to a depth of as much as 4,600 feet, at Tustanowice even to 5,250 feet. At Ratiskovice, near Hodonin, it has been ascertained that light oils can be obtained at greater depth from Oligocene strata. At Bohuslavice, on the Vlara, the first well was drilled about 10 years ago in an orchard. The pipes are still in the ground, and oil has been found in them. It is proposed now to drill for oil in places of greater promise and an order for the shipment of the necessary tools and implements has already been issued.

METHODS EMPLOYED IN BORING OPERATIONS.

Preparations are now being made at Gbely for the boring of the first deep well. Two different methods of boring are employed at Gbely, the choice depending on circumstances: The so-called "flushing" method, and the "dry" method based on the system of Tauk and Franzl. The flushing method possess many advantages over the Canadian method, which is generally employed in Galicia, the chief one being the lower cost of installation. It is said that the flushing method is much more economical, its effectiveness in comparison with the Canadian method being in a ratio of 6 to 1. There is no danger of flooding the mine, but the conditions have to be considered carefully before a decision is made, how far the flushing method may be followed and when the dry method is to be employed. The Canadian method is followed at Stráz, near Sastin, in Slovakia, where a well has been drilled to a depth of 1,115 feet. Traces of oil were found at a depth of 650 feet, but the yield was insufficient, and the boring is continued. Work has been stopped temporarily at Sv. Jány, in Slovakia, where the Sarmatian strata begin only at a depth of 2,600 feet, and where the chance of finding a good supply of oil was small.

OIL PRODUCTION.

In 1918, with 410 workmen employed under military supervision, the production of oil at Gbely amounted to 8,300 metric tons, or over 56,000 barrels of 42 gallons. The average per workman for the year was 20·25 metric tons. The production for 1919, with only 320 workmen employed, is estimated at 7,200 metric tons, or about 22·50 metric tons per operative. These figures do not offer a reliable criterion of the workmen's efficiency, however, as the yield of the wells is not uniform. Well No. 71, for example, yielded about 40 to 50 tons of oil a day at first, but the flow ceased after the output had reached 1,160 tons, and it will take some time before production can be resumed.

OUTPUT PER MAN.

The efficiency of the workmen may be judged approximately by the following figures: In 1918 the borings totalled 17,611 feet, averaging 43 feet per man; the borings for 1919 are estimated at 13,120 feet, averaging 41 feet per man. This slight decrease has been explained as due to the introduction of the eight-hour day, since nine workmen are now employed in three shifts where formerly six workmen would be employed in two shifts at well boring. It should be remembered, however, that in the drilling operations about 40 per cent of the working time is lost by temporary stoppages caused by geological and technical conditions over which the workmen have no control. Such loss of time cannot be made good by intensive labour in short periods. The discipline among the operatives has improved greatly in the course of the year.

VALUE OF OUTPUT.

During the first half of 1919 the oil produced at Gbely was sold partly to the Government railways and partly to private consumers. In July the importation of oil from Galicia was interrupted, and the railway administration became a steady customer, receiving 1,120 tons of oil in that month. The deliveries increased to about 20 tons a day toward the end of the year. The shipments were occasionally interrupted by shortage of tank cars. Production suffered at times by lack of coal. The supply of natural gas is small and will suffice hardly for one boring.

During the war the oil wells of Gbely yielded an annual profit of about 4,000,000 crowns. The net earnings for 1919 are estimated at 8,000,000 crowns. In the Prague "Tribuna" of 31st December, an engineer estimates the value of the Gbely wells at 100,000,000 crowns. The writer protests against the proposed sale of the wells to a semi-public corporation as being in effect a gift of public property to private parties. It has been proposed to form a corporation capitalised at 20,000,000 or 40,000,000 crowns, of which the State should hold 50 per cent, a Galician petroleum company (the "Galicia") 30 per cent, and the Prague Credit Bank 20 per cent.

MODERN MACHINE SHOP PRACTICE AND THE LIMIT GAUGE SYSTEM.

By M. Coronel.

(*Continued from page 248.*)

We now come to the actual methods as employed in a modernly equipped and managed machine shop. Every modern shop should have its specially appointed machine foreman, under whom work a number of charge hands, each charge hand being over a certain class of machine or operations as turret lathes, radial drills, grinding machines, etc.

Fig. 18.—Distance Micrometer.

In larger shops it is advisable to split the machine section into two parts, the larger machine shop and the small details machine shop, and each have then a separate foreman. The small machine shop is placed with advantage on the first floor on a gallery running above and along the length of the larger machine shop. It gives better light for small work

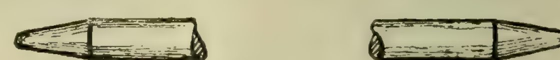


Fig. 19.—Point Gauge Micrometer.

done there, and does not interfere with that of the large machines.

The machine shop should in preference be electrically driven; its advantages are manifold, as less loss of power through empty running shafts, belts and pulleys, no interruption of light, less risk of accidents through clothes getting into belts, etc.

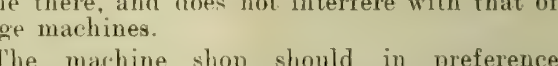


Fig. 20.—Flat Point Gauge Micrometer.

It is further of great advantage to drive all larger machines by individual motors, and group the machines together in groups driven by 30 to 50 H.P. motors, either directly connected or by high-speed wholly enclosed reduction gears. These may either consist of worm or spur reduction, although some firms advocate chain belt reduction gears.

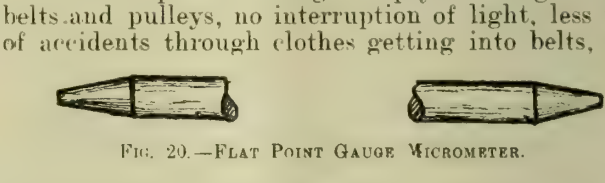


Fig. 21.—Micrometer Depth Gauge.

It is of great advantage to have all machine tools fitted with an adjustable arm of the swivel, gas bracket style, having on its end a vertical inclined reading stand made of light wood after the style of the music stand of a band stand (Fig. 23). Its purpose is to clamp down the drawings by means of flat springs, from which the workman can constantly read the dimensions of the work in hand; this obviates many mistakes being made, keeps the draw-

ings clean and out of the way of oil, dirty places and tools.

The Lathe.—The tendency nowadays is to have all geared lathes with speeds and feeds altered by fixed change gears instead of step-cone pulleys and a set of change wheels to put into the machine every time a change is wanted. The larger sizes have generally an electric motor incorporated in the design.

The *turret and capstan lathe* is a specialised form of the general work lathe; the tool holder is arranged so as to hold four, six or eight different tools simultaneously, each of which is used in turn to perform a function in the process of machining the article in progress. These machines are profitably

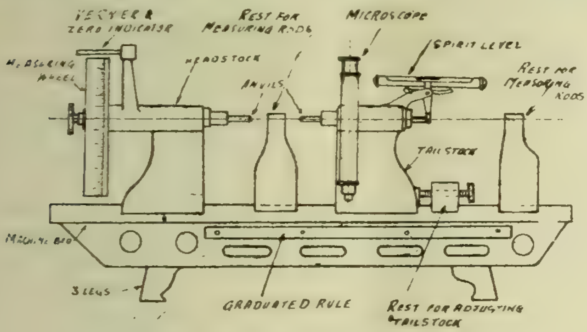


FIG. 22.—FINE MEASURING MACHINE.

used for the manufacture of small repetition parts, as studs, screws, nuts, bolts, pins, knobs and similar articles, although, in some cases, larger parts are with advantage machined on them, they can be more easily worked by semi-skilled labour.

The turret and capstan lathe has taken over to a great extent the work of forging small parts, the tendency being in the same direction with the lathe. Instead of making forgings of bolts, pins, nuts, small gear wheels and worm shafts, these articles are made from hexagonal and round bars, and turned out of

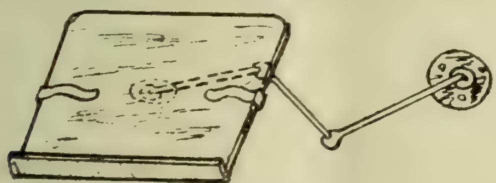


FIG. 23. DRAWING READING DESK.

the solid. Especial spur and bevel wheels are now made from mild steel bars up to 14 in. to 16 in. diameter, and by the use of a suitably adopted lathe for such work it can be done much quicker and cheaper than forging, which is, from the nature of the process, generally very expensive.

Boring mills of the vertical type are used for a great many articles, as pistons and rings for engines, small cylinders, etc., which used to be done in the lathe. Much of the time of setting is saved by the use of duplex vertical mills, as after the first article has been set running, the second can be set, and by the time the first one is finished and a second one is being put on, the other part of the mill is still finishing its work.

The horizontal mill is used for boring large cylinders, facing same in connection with more than one spindle, and are very useful in simultaneously boring out the cylinder and valve boxes of Corliss cylinders.

Planing and shaping machines suffer from the effect of the idle return stroke, and the tendency of the centre of the table slide being used more than

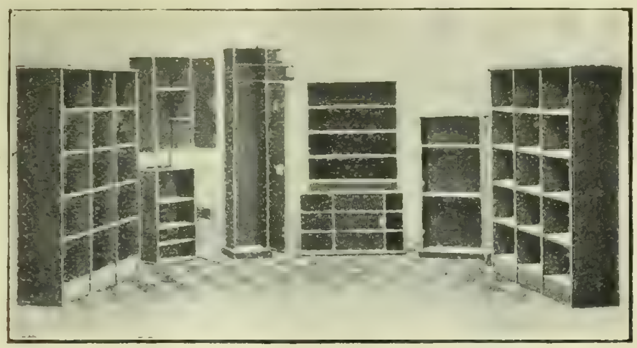


FIG. 24.—TOOL RACKS AND SHELVES.

the rest to wear out more. In consequence, the table and work clamped on it will more or less take the same shape, and planed or shaped surfaces are rarely therefore as accurately straight as the milled surface

The Milling Machine.—A great many operations

FIG. 25. FILING CABINET 4 ft. 3 ins. × 4 ft. 3 ins. × 23 ins. DEEP FOR STORING TAPS, REAMERS, DRILLS, CUTTERS AND GAUGES. CAPACITY 100,000 TAPS.

which used to be done on the planing and shaping machines are therefore, to greater advantage of time and accuracy, done on the milling machine, especially flat surfaces, and quantities can be arranged as on the horizontal planer, as joints of tram motor cases, cross-head slide bars, flat section connecting rods,

etc. Profiling is also a special function of the milling machine, as in the manufacture of turbine blading, cams or cam-shafts, etc., for internal-combustion engines.

The Grinding Machines.—All shafts, pins, brushes and other steel parts which are subject to heavy wear should be hardened. The bearings ground up in a grinding machine, or in the lathe fitted up with a grinding attachment for the purpose. Certain small articles and flat surfaces are profitably ground on a surface grinding machine, provided either with the usual clamping devices or with a magnetic table which holds the work in place. The grinding discs in these machines run at a very high speed, the sides of the disc being used for grinding instead of the periphery of the wheel, and are sprayed with water under pressure. Sight hole door, hand hole covers, name plates and other small unimportant castings are often surface-ground in the modern machine shop instead of planed.

Drilling machines are now habitually used for tapping and reamering holes besides the drilling of them. They have for that purpose an attachment which automatically is put out of gear when overstrained to prevent the tap or reamer being broken. Condenser tube plates, boiler plates, superheater tube plates and the like are generally drilled on multiple drilling machines. The radial drilling machine has for many jobs superseded the older fixed drilling machine for larger work, as in a large casting it is easier to move the drill than the heavy casting, and the radial drill can easily be moved over a large surface. Sensitive drills are used for fine and small work, and rarely for larger than ½ in. or ⅝ in. holes. In connection with drilling machines, jigs are now used in all modern shops having to drill flanges or castings generally to a repeated set of holes. The advantage of using drilling jigs are: doing away of the setting and marking out of the holes to be drilled or bored; perfect security that all the holes in the various castings are exactly in the same place; the prevention of the running out of holes, etc.

The *drilling jig* or boring jig, for that matter, is generally a cast-iron template, wherein the holes to be drilled are provided for; each hole consists of a larger hole furnished with a hardened steel bush to prevent wear of the template hole by the drill.

The template or templates have suitable lugs and projections for clamping and screwing the template jig to the casting to be drilled. Jigs, if carefully designed, should be easily fixed to the part to be machined, and most modren works have nowadays a special jig and fixtures department as part of the drawing office.

The Slotting Machines.—Most of the operations formerly done on these machines are now, with greater advantage and accuracy, done on the various drilling machines with moving table, as armature slots, keyway slots, etc. The disadvantage of the idle return stroke, as by the shaping and planing machine, is abolished when using the milling machine, and the on-set and off-set of the tool entering and leaving the slot does not produce a straight line slot; and further labour saving can be obtained, say for turbo motors slotting, to have four milling cutters running simultaneously; the sag in the centre of the work so often observed with the planer is also found on the work of the slotting machine.

Broaching machines are very useful in replacing and labour saving the work of a fitter of converting a round drilled hole into a square one, or any other shape as required for various purposes, as notched sleeves for machine tools and small couplings, and out-and-in gear clutches of change over gear on motor cars and other various speed-gear devices. It is a machine as yet not much used in the average shop, although the up-to-date machine shop is not without one or more of these machines. The work which can be done with advantage on these machines is not appreciated by many designers and draughtsmen.

The *screwing machines* have, with very few exceptions, made the least advance of modern tools. Some machines have various labour saving contrivances, as the cutting of threads of various diameters, but all having the same pitch; this saves, of course, having to take out the dies for every different diameter to be cut. These are for special work, as screws for instruments and other small parts, automatic screwing machines, and one man can, when once set, attend to several of these machines. There are also used nowadays a combination of a turret lathe and a srewing machine, called turret screwing machines.

Where frequently iron or steel bars have to be cut off, a rotary cold saw, band saw, or hack sawing machine is of great advantage, and saves, on the older method of cutting off the bar hot in the smithy, much time and production cost.

INDUSTRIAL LIGHTING AND ITS RELATION TO EFFICIENCY.*

INDUSTRIAL ILLUMINATION AND HEALTH.

The close relation between light and health has long been recognised by physicians. It is known that absence of light is favourable to the development of tuberculosis and certain other diseases, besides increasing the risk incurred in various dangerous trades. Moreover, employees work more cheerfully in well-lighted premises, whereas dark and gloomy surroundings are depressing to the spirits. It has also been found that where the lighting is good more attention is paid to cleanliness and personal appearance. In all ill-lighted factories refuse is apt to collect, whereas in a well-lighted interior its presence would be obvious, and it would be accordingly removed.

Furthermore, bad illumination enormously increases the effort of working, especially work that makes a severe tax on the eyesight (*e.g.*, in the clothing, sewing, and textile and embroidery trades). The effect of inadequate lighting in causing fatigue is one subject that might well receive attention from the recently-formed Research Board appointed by the Department of Scientific and Industrial Research and the Medical Research Committee last year. The field of work of this Committee covers a general survey of the relation of hours of work and other conditions of employment to the production of fatigue, having regard both to industrial efficiency and the preservation of health.

We have, however, already important evidence indicating generally the prejudicial effects of inadequate lighting, although this matter requires further study in detail.

During the war there were many opportunities of confirming these impressions, owing to the large number of factories under State control and under special supervision. Most valuable work in studying the conditions in such factories was done by the Health of Munition Workers Committee (M.O.M.).

BAD ILLUMINATION AS A CAUSE OF ACCIDENTS.

For some years the part played by poor conditions of illumination in causing accidents has received study, and there is already available a great deal of information on this point. It is obvious

* Abstract of paper by Leon Gaster, hon. secretary of the Illuminating Engineering Society, read before the Royal Society of Arts.

that accidents, which so often arise from failure to perceive, will often be associated with inadequate illumination. In many cases accidents are due to insufficiency of light, but they may be due to other defects; for example, the dazzling effect of a bright light in dark surroundings, or the confusing shadows or abrupt transition from brightness to darkness caused by imperfectly diffused sources of light. Steep stairs and raised platforms with exposed edges should always be well lighted. It is not enough merely to secure sufficient illumination on the area in question; the light should be shaded so that the worker's eyes cannot be dazzled by the glare.

Of all forms accidents liable to be caused by inadequate lighting, special prominence may be given to those arising through "persons falling."

The conditions of access of daylight into buildings, I need scarcely add, also require careful treatment, so much so that the general arrangement and shape of modern factories is very largely governed by this consideration. It would be of great assistance to the lighting expert if architects, in planning buildings, would likewise bear the requirements of artificial lighting in mind, and confer with the illuminating engineer at an early stage in the design.

In the United States much excellent work has been done by "Safety First" Committees, established by many leading manufacturers to examine and correct causes of industrial accidents. On such Committees both employers and workers are represented, and remarkable reductions in the number of accidents have been made by their efforts within quite a short period. Thus, on all Amerian railways deaths and injuries were reduced by 46 per cent in 1916, and large industrial concerns have recorded decreases ranging from 24 per cent to 84 per cent since the movement was initiated. The "safety first" movement in the United States receives very powerful support. Lord Leverhulme, who mentioned this fact in summarising his experiences during a recent visit to the United States, has also stated that the beginning of the "safety first" movement was made in this country; it is only in recent years that developments in the United States have proceeded more rapidly than here.

THE EFFECT OF ILLUMINATION ON OUTPUT AND EFFICIENCY.

It is evident that failure to provide adequate illumination greatly increases the difficulty of supervision and accentuates the tendency to slackness where this exists. On the other hand, good lighting has a bracing effect and inclines men to put out their best efforts. It is clear, too, that a skilled worker cannot put forth his best efforts if he is hampered by difficulty in seeing what he is doing, and that it is folly to pay high wages and instal expensive machinery and then to grudge the relatively small expenditure necessary to put the lighting on a proper basis. The high order of accuracy, the high speed of machinery, and the use of automatic methods make the results of inadequate lighting specially serious. If a tool is wrongly set, a great deal of work may be turned out before the error is rectified. Bad lighting reveals its effect both in slowing down operations and in increasing the amount of spoiled work. This applies alike to engineering operations where things must be made to exact dimensions, and to textile processes where the surface of the material must be carefully studied. Good lighting is essential for the inspection of materials, but an injustice is done to the workers if the lighting conditions by which they execute the work are not as good as those by which the work is subsequently inspected.

Evidence of increased output following improvement in illumination was given by several witnesses before the Departmental Committee on Lighting in Factories and Workshops. In one case noted the earnings of workers increased 11·4 per cent after the installation of better lighting; in another case the output by artificial light, owing to faulty methods of illumination, was 12·30 per cent less than by daylight. The matter is of equal interest to managers and employees. The latter are quick to appreciate the connection between good lighting and earning power. Thus it was stated by Mr. Franklin Thorpe, in a paper read shortly before the war, that in the North of England workers tend to migrate continually to the better lighted mills. It is a common experience that when the lighting of one section of a factory has been improved, workers in other sections also clamour for a similar improvement. Moreover, whilst managers and workers are sometimes slow to admit the full economic benefits of good lighting, one finds that, once an improvement is made, neither will consent to return to the old conditions.

COST OF LIGHTING IN RELATION TO WAGES AND EQUIPMENT.

The economic advantages of proper industrial lighting are again emphasised when one considers the proportion that the cost of lighting forms of other industrial expenses. Mr. Clewell, in a recent article in "Industrial Managements," took as a typical example a room with a floor area of 3,000 square feet, in which 25 employees were at work, earning on the average 25 cents (approximately 1s.) an hour. The total annual wages bill for this area might amount to 25,000 dollars (say £5,000), including superintendence and overhead charges. The annual cost of lighting the area should not exceed 250 dollars (say £50), from which it appeared that the lighting costs only 1 per cent of the wages bill. Naturally, the exact proportion will depend on the wages paid, but it is invariably small. If all the other items forming standing charges on the factory were included, the proportion would be smaller still. Only a very small improvement in output would be needed to compensate for the cost of better lighting, quite apart from the other advantages referred to previously, such as better health of employees, less fatigue, and nerve strain, etc., all of which are difficult to assess commercially.

The results are equally striking if one compares the cost of installing good lighting with the total cost of the erection and equipment of large factories. Thus, Mr. Clewell found that in the Ford Motor Works in the United States the cost of buildings and equipment amounted to 1·64 dollars (say 6s. 6d.) per square foot of floor area, while the lighting installation cost five cents (approximately 2½d.) per square foot, or only 3 per cent of the entire first cost. In this case also the running costs of lighting were small in comparison with the total operating charges, forming only about $^1/_{10}$ per cent.

SOME IMPORTANT POINTS IN GOOD INDUSTRIAL ILLUMINATION.

Having shown the justification for proper industrial lighting, let me next refer to some of the most important principles involved. Scientific illumination is only obtained when lighting is studied in relation to the processes carried on. The lighting expert needs to be familiar with these processes as well as his own speciality, the principles of illumination. But as a result of the discussions before the Illuminating Engineering Society during the past ten years, the fundamental principles have been clarified, much information on special lighting problems has been obtained, and there are now men in a position to give good advice.

One important element in progress has been the development of simple forms of instruments for measuring illumination. By means of many measurements of illumination in factories we have ascertained what great variations in illumination exist, and where waste occurs. We are able to verify by actual measurement estimates of the illumination to be provided. Above all, we know the existing order of illumination prevailing in factories, and can determine when recommendations are practicable. Then the large number of measurements, upwards of 4,000, made by the Departmental Committee on Lighting in Factories and Workshops, was extremely helpful in fixing standards.

Good lighting, however, is not merely a matter of providing sufficient illumination. Other important points include: Uniform illumination over the working area; the placing or shading of lamps so that the light does not fall directly in the eyes of workers when engaged on their work, nor when looking horizontally across the workroom; the placing of lights so as to avoid the casting of inconvenient extraneous shadows on the work.

The choice of suitable forms of reflectors, so as to secure even illumination and absence of troublesome shadows, is of great importance. Light tinted walls and ceilings are of great assistance in eliminating such shadows and promoting good diffusion of light.

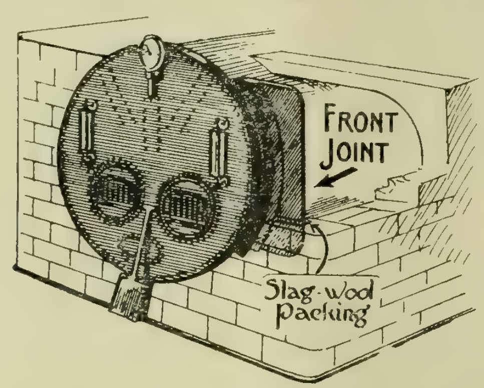
It is most desirable that lamps, reflectors, etc., should be regularly cleaned and maintained. A few months' neglect may result in a loss of as much as 50 per cent of the working illumination, and cases are on record where, by merely making good defects and cleaning lamps and appliances, the available illumination was doubled.

During the war manufacturers were so fully occupied in meeting demands for standard types of lamps and reflectors, etc., for essential work, that there was not much opportunity for introducing new designs. Much attention has been devoted to industrial lighting, and the illumination of munitions works. It was fortunate that the leading firms concerned with lamps and lighting appliances had already formed illuminating engineering departments, and could thus both supply lighting apparatus and advise on its use. Here the country reaped the reward of the work of the Illuminating Engineering Society in the years preceding the war. Both gas and electric lighting have played a great part in promoting industrial progress. A feature of modern methods is the use of the latest and most efficient units, such as

high-pressure gas or gas-filled ("half-watt") electric lamps, placed high up out of the direct view of workers, and affording a clear space for the supervision of the workroom. The electric gas-filled lamp, comparatively unfamiliar at the outbreak of war, has since been much used for industrial lighting, and great care has been devoted to the design of special fittings for use with this form of lamp. Amongst such devices may be mentioned the air-tight forms of lanterns suitable for use in munitions works, or placed where chemical fumes are present.

PATENT BOILER JOINTS.

Economy in the use of coal necessitates efficiency in the boiler plant. At the rear of most boilers the "downtake" is separated from the side flues by fender walls butting on to the end of the boiler. There is invariably a space of 2 in. at this point, and a portion of the heated gases take a short cut direct to the chimney—obviously, their heat value is lost.



In the illustrations given herewith, ingenious boiler joints are shown. In the first, an expansion joint between the boiler face and brickwork is shown. It is stated that displacement of the brickwork is impossible, and the side flues are permanently safe from entry of coal air. More perfect combustion is claimed, together with a considerable reduction of black smoke.

In the second illustration an expansion joint between the fender walls and back end of boiler will be seen. All brickwork about the joint is securely bonded by patented reinforcement. No springs are used. Like the front joint, the displacement of brickwork is impossible; also, the short circuit from the "downtake" to the chimney is permanently stopped. The makers are The General Engineering Supplies Co. Ltd., 17, Brazennose Street, Manchester.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

*Official Lecture: "Structural Design of a 40-Ton Titan Crane." By P. A. Arbenz and H. W. Mellor (Members).

The Authors cover an immense field, and offer a prodigious crop of results. The vastness of the range has necessitated that in parts the treatment should be suggestive rather than exhaustive. To enter upon detail, as perhaps some readers would like, would involve the space necessary not for one lecture, but at least four. But this is in no way peculiar to this particular paper. Indeed, it would seem to be more or less common to the whole series.

If the ordinary reader would understand thoroughly that which he reads, he must needs read carefully, elaborate certain processes, and possibly drill his graphics into order. This is, however, no wise an unrelieved misfortune, if he be really keen. The paper, practically of necessity, is as it is. Under the circumstances, as it is, it is well as it is. Whether we be don or dud, there is that which shall interest or instruct, and if we be keen set we shall find the paper both interesting and instructive.

The work the crane does is described, and the general features of the design are outlined. Internal loading, borne by the hoisting ropes, as well as that due to the rocking ropes, and dependent upon the tractive resistance which opposes the motion of the jenny, is duly considered.

So far as the main stresses are concerned, the writers deal with the distribution of dead weights and the stress diagrams for these; and they treat of stresses due directly to the rolling load, and also of those which result from the slewing of the structure and the rolling load. The question of wind stresses is considered. The Authors also indicate how the various stresses must be summated—thus, top and bottom booms, web members, and wind bracings are dealt with. The travelling truck support is the final item, and is treated at considerable length.

Diagrams and other illustrations are admirable. Certain large size illustrations appear at the end of the paper. A footnote stating this would possibly have been of advantage.

This is a paper which might well be added to any engineer's library. W. Roland Needham.

* Price: To members, 1s.; to non-members, 2s.

Review.

ROTARY CONVERTERS: THEIR DESIGN, CONSTRUCTION, AND USE. By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E. London: S. Rentell and Co. Ltd., 36, Maiden Lane, Strand, W.C.2.

A small practical handbook on rotary converters has long been needed. Many of these machines have been installed in substations and similar places, and young engineers and others frequently require information concerning their erection and operation. This little book by Mr. C. Sylvester deals in a clear and concise manner with practically all the technical problems that arise, and it should prove of great value to sub-station attendants. In the first section of the book, the author describes a small rotary converter which he has made, and he then proceeds to consider large machines as commonly installed in sub-stations. The various methods of starting and regulating the voltage of rotary converters are discussed, and some useful wiring diagrams are given. The only regulating scheme the author does not describe is the split-pole system, but as this is very rarely used in this country, Mr. Sylvester cannot be blamed for neglecting it. One important matter which he ought to have touched upon, however, is that of "phasing out" the alternating current connections before machines are first set to work. It is, of course, necessary to ensure that the transformer phases correspond with those of the converter, otherwise, when the alternating current switch is closed, very heavy currents may be set up in the transformer and armature windings. The connections can, however, readily be tested by means of lamps, and it is a matter of regret that the author has not shown how the test is made. Letters calling for information relative to the matter have frequently appeared in the technical press, and a few brief notes on "phasing out," accompanied by a diagram, would have added to the value of the book. Another matter that calls for criticism is the author's remarks concerning the question of preventing rotary converters flashing over. The author says that, for efficient running, the circuit breakers on both the A.C. and D.C. sides should act together, and goes on to advocate that they should be interlocked. This, of course,

may be desirable, but the system presents the disadvantage of shutting the machine down when heavy short circuits occur. Moreover, flashing over may take place before circuit breakers have time to open. In America a great deal of experimental work has been carried out with a view to eliminating this trouble, and it has been reported that, with the use of special "arc quenchers" attached to the brushes and barriers between the brush spindles and special direct-current circuit breakers which open the circuit very rapidly, the trouble has been completely overcome. The breakers interrupt the circuit in two steps, the first step introducing resistance into the circuit, whilst the second step breaks the circuit altogether. It is said that even when high-voltage converters are directly short-circuited, there is no serious flashing at the brushes. In fairness to the author, however, it is only right to mention that he is dealing with a fairly big subject in a small amount of space. The book contains slightly less than 60 pages, and on the whole it covers the subject extremely well.

Trade Items, Notes, &c.

"Revergen" Furnaces.—Briefly stated, the Davis "Revergen" principle is a system of town's gas furnace firing, by means of which heat losses, by way of the furnace flue or flues, are reduced to an insignificant minimum, and the thermal energy thus recovered utilised almost exclusively for the practical purposes of the furnace. The Davis

Revergen Furnaces.

Furnace Co., 56, Rathbone Place, London, have forwarded to us the interesting illustration given herewith, which shows "Revergen" furnaces in process of erection at their Luton works for Messrs. Wolseley Motors Ltd.

Diesel Engine Users' Association.—The subject of "Connecting-rod Bolts" was further discussed at the last meeting of the Diesel Engine Users' Association. Mr. J. L. Chaloner agreed that it was a very difficult matter to lay down any definite rules as to the period after which connecting-rod bolts should be renewed. He thought, however, that a definite period might be fixed after which a connecting-rod bolt should be subjected to a careful examination by means of suitable measuring marks, and that it should then be left to the discretion of the Chief Engineer as to whether the bolt was to be renewed. The whole discussion had been most useful and of great interest, and it had brought out the fact that great controversies existed on even a comparatively small engine detail amongst manufacturers and users. No other technical institution, international or otherwise, had devoted such close attention to such practical problems connected with the running of Diesel engines, and he felt that this work was bound to further increase the esteem of the heavy-oil engine industry at home and abroad for the Diesel Engine Users' Association. Mr. Geoffrey Porter referred to the desirability of calculating bolt sections on a basis of the elastic limit rather than on that of the ultimate stress. He also suggested that the working temperature of an engine might well affect the tightness of a nut, especially if there was much difference between the temperature co-efficients of the bolt, the nut, the bearing brasses, and the caps. Mr. G. W. F. Horner submitted a sketch of an arrangement he had made use of in carrying out a series of tensile tests with loading conditions similar to those set up in the bolts under discussion, and he showed a series of diagrams giving the results of the tests. In regard to heat treatment of steel bolts, he emphasised the importance of having this carried out by careful and experienced persons, as it was very easy to obtain a high elastic limit and ultimate stress with a very low percentage elongation, and these were undesirable conditions of material used for fastenments. In regard to the packing pieces between the halves of the big-end bearings, he was of opinion that it was advisable to use one uniform thick piece rather than a few thin pieces. A very interesting communication was read from Mr. Charles Day, in which he gave the results of investigations which had been carried out at Stockport for some time past in regard to connecting-rod bolts. He divided the stresses which caused trouble with bolts into those caused by excessive friction of pistons, improper tightening up of the bolts and slack bearings. In regard to heat treatment, the practice which he had adopted was that the material should be heat treated in the bar. The advantage of heat treating the bar, instead of the bolt, was that the bar, being of uniform section, internal strains were avoided, whereas when bolts were heat treated there was a danger of such internal strains occurring at the bottom of the threads and at any other parts where changes of section occurred. Mr. Day condemned the practice of drilling only one pin-hole through a bolt in connection with the use of castellated nuts. The castellations should be as numerous as the diameter would permit, and several holes should be put through the bolt. With regard to renewals of bolts, he thought that any general recommendation was illogical. Certain bolts might work with safety for many years, whereas on the other hand other bolts failed after a very short time, the failure being due to the bolts having been subjected to improper conditions. He described a method of marking bolts so as to permit of accurate measurements being taken which would show at any time if they had been stretched or twisted. Whenever a bolt had been materially stretched or twisted it should be rejected and replaced by a new one.

Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

LUBRICATING.

129,031.—Siddeley-Deasy Motor Car Co., F. M. Green, and S. D. Heron, Parkside, Coventry.—Sept. 28th, 1917.—To avoid leakage

FIG 2.

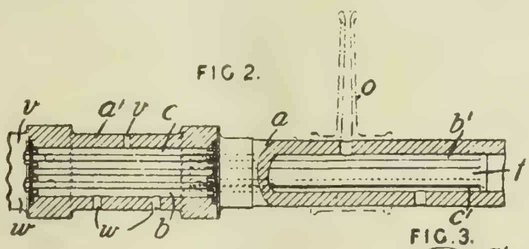
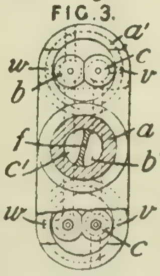


FIG. 3.

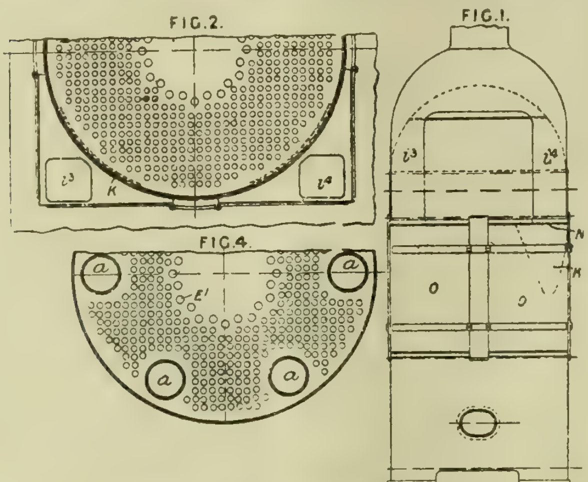


and waste in the lubrication of the crank-pins of aircraft engines, etc., oil is supplied under pressure to one part of the bearing-surface and is removed from another part by suction

A bore in the crank-shaft a is divided by a partition f into two passages $b1$, $c1$, each of which communicates with a separate passage b or c running through the cranks and crank-pins $a1$. Holes v, w connect the passages to diametrically opposite parts of the bearing-surfaces. Oil is pumped through one passage and is drawn through the other by suction of a pump, or by a centrifugal device consisting of a revolving radial pipe o formed with a restricted orifice. The feed of oil may be varied by altering the number or size of the ports v, w, or by varyng the output of the feed and exhaust pumps.

STEAM-GENERATORS.

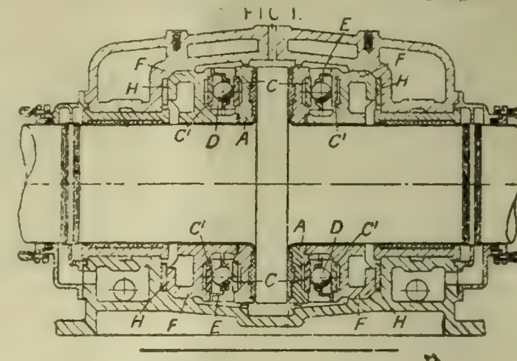
129,047.—R. J. SMITH, 3, Richmond Road, Lincoln.—Sept 5th, 1918.—In the water-tube boiler described in the parent Specification, the gases are led to the chimney through uptakes $i3$, $i4$, Figs. 1 and 2, disposed at the corners of a combustion chamber casing O of square form. Curved baffle-plates K are secured to the upper tube-plate N concentrically with the periphery of the



drums. The smoke-tubes in the upper drum may be replaced by welded uptakes a, Fig. 4, secured to the tube-plate and crown-plate of the drum by riveted seams. The water tubes E1 at the centre of the combustion chamber may be larger and more widely spaced than the other water-tubes. The smoke-tubes in the upper drum may be arranged in triangular sets.

BEARINGS.

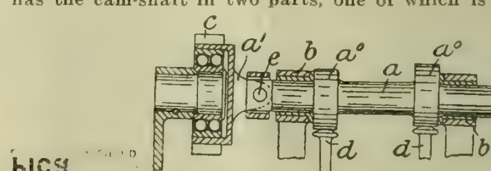
129,108.—B. R. WINGFIELD, of Power Plant Co., West Drayton, Middlesex.—July 3rd, 1918.—In a thrust or collar bearing having pivoted blocks as described in Specification 875/05, the blocks A are pivoted on hardened steel balls D bearing against spring



discs C, C1 inserted in the backs of the blocks and in a thrust ring F. The balls are mounted in a cage E bolted to the ring F. The blocks A are cast as a ring, and the discs C are inserted and are ground in position before the blocks are separated. Axial adjustment is effected by loose rings H.

VALVES.

130,318.—H. V. J. JOUFFRET, 27, Rue Ybry, Neuilly-sur-Seine, France.—June 4th, 1919.—A valve-actuating device comprising a cam-shaft arranged to operate directly the parts controlled and particularly adapted for use with internal-combustion engines has the cam-shaft in two parts, one of which is easily dismount-



able. The cams a° are carried by a shaft a rotating in bearings b and connected to the driving-sprocket c by a hinged joint e so that when the bearings are dismounted, the shaft may be turned up to give access to the valves d. An ordinary jointed connection, a sleeve coupling, or a cardan joint may be used in place of the hinged joint.

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CONTENTS.

EDITORIAL.

ELECTRICITY AND EXPANSION.

CHEAP power easily distributed and utilised is absolutey necessary for the extension of our industries. The rapid strides made by many foreign countries prior to the war, the establishment of outlying factories often admirably placed in regard to their supply of raw material, but isolated in other respects, was due to the easy distribution of power. For many years we were handicapped in this country owing to the prohibition of overhead transmission lines—a handicap that has since been removed.

Following the publication of the report of the Coal Conservation Sub-committee, it was freely stated that we should soon have enormous generating stations located in the coalfields, which, few in number, would by their size and capacity be able to supply the country with cheap electricity. Possibly a few people believed this, but they were laymen, and did not appreciate the true facts. That we should scrap our existing plant is surely neither feasible or economically sound.

The passing of the Electricity (Supply) Act last year has opened up a new vista, and it is fairly obvious that in carrying out the meaning of this Act municipal bodies under public control will be called upon to finance the undertaking. It would not be financially sound to attempt the large superstations suggested. As pointed out by Mr. Thos. Roles, in his presidential address at the recent I.M.E.A. conventions, "immediate demands for electricity must in the national interest be met, and this will for the time being entail the extension of many existing generating stations, whether good, bad, or indifferent."

It is not so much a question at present of superquality as expediency. Unfortunately, through many causes, one cannot determine which is the most serious, expansion in industry has been scotched. and at the present time many jobs are being held over. But it must be realised that this slump is only temporary, that it is a snag that will be cleared away before long, and that immediately confidence is restored we shall be in for a wave of expansion in everyone of our industries.

The question then will arise as to the means of driving the new machinery, and it appears sound reasoning to believe that electricity will be largely adopted. Its claims are many, and have been amply justified in the past. The greatest handicap, of course, lies in the cost. Reduce this and there will be an immediate rush to buy current. In Lancashire economical steam drives are well established. Electrical engineers have been well up against it in trying to oust the old-established medium-running steam engine with its rope transmission. One can only hope that the whole of the I.M.E.A. recognise, as does Mr. Roles, that "the provision of an adequate supply of electricity at the cheapest possible prices is an absolute necessity to the welfare of this country and its inhabitants, and I should not be prepared to allow any interest, either municipal or private, to stand in the way of such an adequate and cheap supply being furnished."

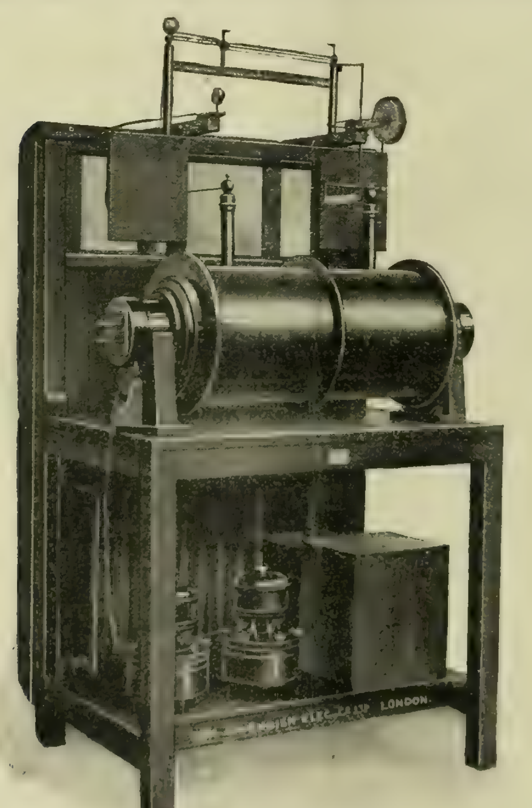
PETROL TRACTION PLANT IN MINES.—The Commercial Secretary to H.M. Embassy in Brussels reports to the Department of Overseas Trade that, by a recent decree published in the *Moniteur Belge*, the law prohibiting the use of petrol locomotives in mines has been abrogated. Their utilisation will, however, remain prohibited in mines falling under the third class; that is to say, those where fire-damp is particularly prevalent. but in other cases authorisation can be given by the provincial council concerned on the recommendation of the Chief Engineer and Inspector-General of Mines.

THE EXAMINATION OF MATERIALS BY X-RAY.

Its Usefulness and Limitations.

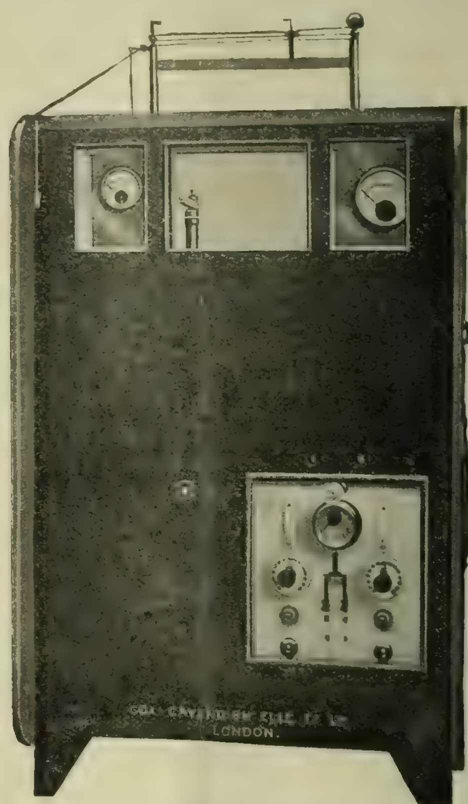
The development of the X-ray has now made it possible to carefully examine the internal structure of forgings and castings, and is a big step forward in the evolution of engineering into an exact science. It is not an uncommon thing for a steam cylinder or similar casting to be not only machined, but tested and passed, and yet in a short time it will become porous or crack. A small hole on the surface of a casting is sometimes a means of detecting a large internal cavity. Steel castings are frequently porous under the skin, and this can be readily proved by the examination of a number of steel castings before and after they have been machined. This is one reason why, in the past, designers have favoured forgings, although they are more costly. The X-ray cannot improve bad castings or welds, but the prospect of the discovery of flaws ensures that proper methods are adopted to secure good results.

Its range of usefulness is at present limited, but one can foresee its great possibilities in the future. The construction of apparatus is all the time being



Front View of Apparatus.

improved upon, and it should ultimately be possible to take radiographs of the thickest castings. Radiographs of steel and iron 2 in. thick can yet be effected, and timber up to 18 in. thick. Even if it is never used universally in the shops, its value in the laboratory cannot be overestimated. It will probably be used in the workshops for the examination of all castings for high-speed work that will be subject to excessive strain. It is now proving a great help to engineers who are paying particular attention to the welding of metals by the oxy-acetylene and electric arc processes. The welding, instead of the rivetting of ships plates, is a recent innovation, and it is yet uncertain how far it will be successful, and whether the welds will withstand the strain to which they will be subjected at sea; experi-



Back View of Apparatus.

ence and examination of the welds will almost certainly result in modifications and improvements. It is not always necessary to photograph the material, for in the quantity production of small parts this would entail great expense. If the parts are thin or their density is low, visual examination on a screen is quicker and more practical for routine inspection than photographing it.

Good and Bad Metal.

Blowholes are not as dangerous as porous patches because they are more easily detected. In an X-ray photograph, porous parts and blisters are well defined, being lighter than the surrounding metal, and a bad weld is evident if the edges of the joining plates stand out. The fact that different qualities of metal are distinctly shown by a difference in shades, demonstrates the success or failure of an alloy, clearly showing if there is a lack of homogeneity, and this characteristic is also valuable in discovering whether core wires or core supporting chaplets have been cast in work. All engineers know that chaplets are a source of weakness, especially in high-speed work, but the moulder uses them to simplify his work. There is also a clear distinction on the X-ray photograph between ferrous and non-ferrous metals.

Materials other than Iron.

Until the development of the areoplane, wood was not subjected to great strains, but it is essential that every spar of a fusillage, that every laminæ of a tractor or propellor, that all hollow parts and glued plywood, should be made of flawless timber perfectly jointed. Worm holes and windshakes, resin pockets and dead knots, twisted grain and sap wood, are grave defects, and show up clearly in an X-ray photograph. The purity of electrical materials, such as mica and fibre, can be ascertained, and one can readily expect that the examination of reinforced concrete, the use of which in shipbuilding is still experimental, will be one of its future uses.

Difficulties.

Taking an X-ray photograph is not difficult, but skill is necessary both in exposing the plate and developing it. Short exposures are recommended, as lessening the danger of spoiling the plate from secondary radiation, which results in fogging. The secondary radiation may be crudely expressed as the refraction of the X-ray from any particle of matter it strikes back on to the object being photographed. Thus, many weaker rays may be acting with the primary rays, and when these secondary rays are excessive, instead of the object being clearly outlined on the plate, it is evenly fogged or darkened all over like an ordinary photographic plate exposed out of focus. The secondary rays are, however, easily absorbed. Progress will be made in this direction in the near future, but at present it is usual to protect the back of the plate by placing it in a lead dish. The protection of the top of the plate is more difficult, but it is usually possible to make a sheet lead frame covering all of the plates except that part covered by the article being X-rayed.

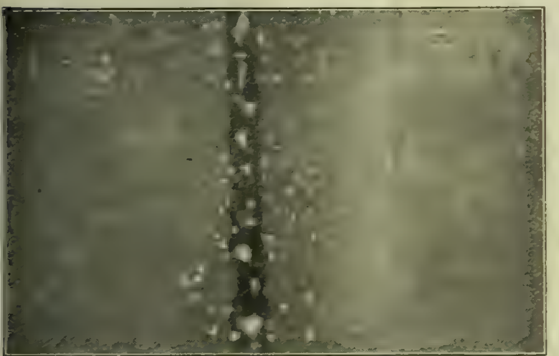
Other methods of coping with this secondary radiation, especially suitable for irregular shaped work, is to fasten it to the bottom of a cardboard or aluminium tray, using wax as an adhesive and pouring lead or mercury round it. The danger from secondary radiation is greater when photographing thick material because of the longer exposure required.

The Necessary Apparatus.

In points of detail the apparatus depends on the class of work to be operated upon. It is not possible to say that one part of the equipment is more important than another, as all are essential. The high-tension current, which is undirectional, may be produced with an induction coil and interrupter, or a transformer and a rectifier. The methods appear to be equally good, and if the induction coil is lighter the transformer is simpler, and simple methods, especially for workshops, are commendable.

The Coolidge X-ray tube is in most general use. Without attempting a technical description of it in this short article, it may be said that its great vacuum and its freedom from gas are its important qualities. It is impossible to pass a current through it, as the vacuum is one thousand times greater than the ordinary tube. The box or case for the tube is coated with rubber and lead oxide, which, being a good insulator and opaque, prevents rays leakage. The shape and size of the box depend on the article that has to be photographed.

Intensifying screens are used to reduce the time of the exposure. If such a screen, which is coated with calcium tungsten, is in direct contact with the plate during exposure, only one-twelfth the time is necessary. The action of the calcium tungsten is to give a highly actinic florescence under the rays, and the action of the rays is thus strengthened. If a second screen is used, the time may be reduced to one-twentieth that taken with a plate only.



Radiograph of Weld in Mild Steel.

Radiograph of Soldered Joint.

High-speed plates are used, but celluloid films are gaining favour, both sides having sensitized surfaces to get the best results with the intensifying screens. The film is held in a container.

How a Photograph is Taken.

The work and the instrument have to be so placed in relation to each other that there will be the minimum rays obliquity. The plate is then screened to minimise the danger of secondary radiation. Ten inches is the usual distance between the tube and the plate, but this depends greatly on circumstances. The set has now to be adjusted, as the radiation depends upon the material being operated upon. While the current is being regulated, the plates are enclosed in a lead case. The length of exposure necessary depends upon the specific gravity of the material.

As in ordinary photography, the developing of the plate is even more important than the exposure, and the same precautions have to be taken as in photography.

Health Safeguards.

The ultimate success of all scientific devices in the workshop depends to a considerable extent on the

effect they have on the health of the operator. This matter receives more attention than formerly. There is no reason why X-ray photography should be injurious to health. A lead screen fitted with a thick flint glass window is placed between the operator and the X-ray tube, thus preventing the rays falling upon him. All the controls pass through the lead screen. The danger from which the operator is protected by this screen is of secondary radiation, as the opaque covering of the tube effectively cuts off primary radiation.

PETROLEUM IN TRINIDAD.

Considerable attention has lately been attracted to Trinidad in connection with the oil boom throughout the world, and there has been a rapid movement to organise new companies to drill for petroleum in the island. Competition for the purchase of lands thought to be oil-bearing has been keen, and prices have been as high as £100 an acre when indications seemed especially favourable. This applies, of course, only to private lands, as all Crown lands in the mineral-oil districts have long since been leased to British companies.

The island of Trinidad has an area of 1,754 square miles. The petroleum indications are confined to the southern part of the island, and particularly along several more or less clearly defined anticlines, which follow an approximately east to west course. The oil-bearing lands of the island are officially defined in the local regulations, as all lands south of latitude 10° 26′ 36″ N. The oil-beds occur in the tertiary strata, which reach a total estimated thickness of from 6,000 ft. to 7,000 ft., and the productive sources are chiefly confined to two main horizons, which show great persistence over long distances.

The southern anticline of Trinidad, where the beds are steeply inclined, has been traced over the whole length of the southern coast, which it closely follows; the crest only occasionally leaves the land and enters the sea, and never passes far from land. A few miles north of the main southern anticline is a second fairly persistent anticline running also in a direction roughly parallel with the southern, but on this anticline an oil horizon much higher in the series is brought to the surface. Further north are other anticlines, which can be distinctly traced for long distances in some cases, but they are not so clearly defined as the southern and central anticlines.

On the southern anticline there are many petroliferous strata of apparently no great importance outcropping at intervals, but near the crest, where the main oil zone closely approaches the surface and where the sands of the zone are not too thickly covered with clays, indications of petroleum are to be observed on an extensive scale. At many points where the sands of this horizon lie near the surface, important issues of high-grade petroleum may be observed, saturating the surface sands and soils in the vicinity.

The greatest manifestation of petroleum in Trinidad is the famous Asphalt Lake, which covers a flat area of approximately 120 acres, about 27 miles south of Port of Spain, the capital, and about half a mile from the Gulf of Paria. Early last year a low-depth record of 150 ft. was obtained with difficulty by boring appliances. The asphalt product of this lake contains the heavy constituents of petroleum oil, and was evidently formed from petroleum which had escaped from oil sands.

Another interesting manifestation of petroleum in Trinidad is manjak, a black, solid, friable bitumen, which has evidently been derived from heavy petroleum traversing fissures in clays, which have caused the abstraction of the lighter constituents, leaving only a solid mass. Also, the issue of hydro-carbon gas is another important indication of petroleum, especially on the Cedros Peninsula at the south-western extremity of the island, where there is a long succession of mud volcanoes nearly always in activity, and in which sometimes violent explosions occur. In 1911, just south of the Cedros Peninsula, a small island suddenly formed, but lasted only about a day, having been caused, it is understood, by subterranean explosion of gas. In addition to such indications of petroleum, there were noticed many years ago in Trinidad practically all the essential conditions for the accumulation of oil, if it existed at all. There were beds of sands of sufficent thickness to store large quantities of oil—sands which exhibited a high degree of saturation where exposed. There were also thick coverings of an impervious clay suitable for the preservation of the oil, and there were anticlines where concentration could take place.

It was not, however, until about the year 1901 that any oil was obtained by boring operations. The pioneers of the Trinidad petroleum industry had to face considerable difficulties. Many of the best localities are clothed in dense jungle, through which there are no roads or waterways. Forests have to be cleared and roads made before any machinery can be conveyed to the sites selected. Another considerable difficulty is the prevalence of fevers; camps have to be specially drained, and houses screened from mosquitoes. Gradually, however, companies were formed, several meeting with fair success.

Up to December 31, 1918, according to the local Inspector of Mines, the total number of wells drilled in the colony amounted to 410, of which 236 are on Crown lands and 174 on private lands. There were 41 new wells drilled during 1918 (37 on Crown and 4 on private lands), and in 29 of these oil was struck. There were 12 companies engaged in producing oil at the end of the year 1918. The production of oil in 1918 showed an increase of nearly 30 per cent over that of the previous year. The total production of oil in 1918 in Imperial gallons (42 Imperial gallons to one barrel) was 72,872,398, as against 56,080,914 in 1917. In 1918, 54,238 ft. were drilled as against 52,037 ft. in 1917. The production of oil on Crown lands in 1918 was just about double the production of oil on private lands. Out of the total production in 1918 of 72,872,398 Imperial gallons, there were 27,920,015 Imperial gallons taken by ships for bunker purposes, 12,936,283 Imperial gallons exported, and the balance of 32,016,100 Imperial gallons used for local consumption. The oil exported was crude petroleum, which was sold to the Admiralty.

According to a report by the United States Consul in Trinidad, at the beginning of 1919 there were 12 companies engaged in producing oil in the island, but only those with considerable capital or financial

backing have thus far met with any real success, notwithstanding that it is comparatively easy to find some oil on the anticlines without particularly deep boring; practically all the oil thus far produced coming from shallow sands less than 2,000 ft. deep. The difficulty with production, in the case of every company operating, is, that while wells produce encouragingly at first, the production tends to fall off quickly, and good gushers often become choked by sand very soon The anticlines are steep, and the pools usually narrow, so that the wells are not very large.

Apparently the best pool in Trinidad is that at Fyzabad, and the success in this district has caused considerable speculation in adjacent lands, and the organisation of new companies to commence operations. About 15,000 barrels of petroleum have recently been produced from three wells adjoining the Fyzabad field. The heaviest oil in the southern fields, including Fyzabad and Brighton, is about 12 deg. Baumé. The best oil from Trinidad runs as high as 45 deg. to 46 deg. Baumé, and will produce 35 to 40 per cent motor spirit and the same percentage of kerosene. The petroleum from this field is understood to be unsurpassed in quality by any oils found anywhere in the world, but its production up to the present has been comparatively limited.

The principal reasons why Trinidad attracts much attention as a field of possible profitable and continuous development of petroleum industry are: First, the favourable indications of petroleum extending over long distances where there are unusually extensive displays of natural phenomena, such as are often associated with important oil fields; second, the favourable, though not necessarily ideal, structure which in many cases characterises the strata amidst which the oil sands are distributed; third, the satisfactory yields often obtained from shallow wells drilled at widely separated localities; fourth, the proximity of most of the promising oil districts to the sea; and, fifth, Trinidad's exceptional geographical position with regard to the markets of the world, especially with reference to important routes of commerce. A large number of vessels now equipped to use fuel oil instead of coal find it very convenient to stop at Trinidad to secure oil for bunker purposes. This is especially true of vessels in trade between North and South America, and of those passing through the Panama Canal. Between such ports as Buenos Aires or Rio de Janeiro and New York it is often extremely convenient for vessels to stop at Trinidad to replenish bunkers with oil, and sometimes continuation of voyages would hardly be possible without calling there to replenish bunkers.

There is also a good local market in the West Indies for petroleum products. In Trinidad itself, fuel oil has now almost entirely supplanted coal for all industrial purposes owing to its cheapness, its higher calorific efficiency per ton, and its convenience in handling.

The Trinidad Government Railway has lately been equipping its locomotives with oil burners, so that fuel oil can be used instead of coal; and the local Gulf steamers now use oil instead of coal. The municipalities of Port of Spain and San Fernando utilise fuel oil for operating their waterworks; moreover, in Port of Spain, fuel oil is used for operating the tramway system and the electric lighting plant. Considerable use, also, is made of crude oil on pavements for disinfecting purposes, and, in the campaign against malaria, for preventing stagnant pools of water becoming breeding places for mosquitoes. There is also considerable use of kerosene for lighting purposes.

Although Trinidad as an oil-producing country has advantages as above explained, nevertheless the industry, up to the present time, can hardly be considered to have yielded very favourable financial results—at least as compared with the best-known developments in the United States, Mexico, and other important petroleum-producing countries. The heavy gas pressures and soft shifting formations in Trinidad have proved serious obstacles to economic development, and constant disappointments are experienced by wells gushing most violently at first, and to such an extent that but little of the oil can be saved, and then, perhaps, in a few hours becoming so clogged by rocks and sand that production stops almost as suddenly as it began. The average life of good producing wells is apt to be very short, so that constant investment of new capital is necessary to keep up any large aggregate of production, and constant extension of drilling operations is necessary in order to reap the benefit of heavy outlays upon pipe lines, storage accommodations, shipping facilities, and other works of a permanent character. It seems probable that more scientific attention to the peculiar conditions of Trinidad, as regards its strata levels of soft rocks, shales, sandstones, and clay, with improved methods of drilling to take into account such conditions, would result in more substantial success in producing large quantities of oil and maintaining longer periods of production of wells striking oil.

The most interesting possibilities of the future, as regards the oil industry in Trinidad, might be in drilling wells of far greater depths than have as yet been attempted. In the field of operations of one important company, the policy at present is to deepen existing wells, instead of drilling new ones, and the results thus far seem quite promising; not only more oil, but oil with a world record in quality, has been found at lower depths. But, as yet, there has been no drilling lower than 3,000 ft. The difficulty, which has for some time existed, of securing sufficient supplies of well casing and pipes, has considerably retarded many important operations. Some of the leading geological experts who have visited Trinidad are of the opinion that if drilling operations should ever be conducted considerably below the comparatively shallow depths thus far reached (as has been done in other countries, where great success has been attained), almost unlimited supplies of oil might be found, and the local industry placed on a far more substantial basis than at present.—"Journal of the Royal Society of Arts."

Wild-Barfield Furnaces.—We have published quite a considerable amount of matter relating to work done with the Wild-Barfield electric furnaces, and have just received an advance copy of a new catalogue in which several large-sized furnaces are described and illustrated. These furnaces have been specially designed to meet the increasing demand for mass-production and also the hardening of very long articles, such as camshafts, tools, gear wheels, etc. The catalogue is excellently produced, and contains much interesting matter.

ELECTRIC RESISTANCE WELDING.

By E. AUSTIN.

Progress of Electric Welding.

During the last few years electric resistance welding has made great progress, but there are still many manufacturers who apparently do not recognise its immense advantages. Spot welders, for example, save the cost of rivets and also a great deal of labour. There is no marking off, no holes to punch and no rivets to fit into holes. The advantages of butt welding have also been found to be very marked. Innumerable examples might be cited to show what butt welding machines can accomplish, but it will suffice to mention that in a certain shop two blacksmiths, two strikers and two labourers were originally employed on welding $2\frac{1}{2}$ in. diameter crankshafts, and the time taken to perform the work was twenty-five minutes On installing a butt welding machine, however, two men were able to do the work in ten minutes. Moreover, when the work was done on the forge alignment was not always perfect, and much time was frequently lost in straightening the work and in subsequent turning. The butt welder completely eliminated these troubles, and enabled bright stock metal to be welded to the cranks, thereby minimising the amount of turning. Seam welding in accordance with the resistance method can also be carried out with great rapidity. In the manufacture of cans, for example, resistance seam welding has proved very advantageous, experience having shown that cans composed of 26 gauge metal, 9 in. long and 6 in. in diameter, can be welded so that they are perfectly oil-tight at the bottom and on the longitudinal seams at a rate of 90 per hour.

Machine Employed.

A spot welding machine has two arms or stakes fitted with pointed water-cooled electrodes, and is used for joining plates in such a manner that the mechanical effect is equivalent to riveting. Small welds are made at regular intervals, and each of these welds is in the form of a circular spot varying from about $\frac{1}{16}$ in. in diameter to $\frac{3}{16}$ in. in diameter. The current used is a heavy one, but as the pressure never exceeds a few volts, the electrical energy consumed by the machine is not by any means great. A good example of a spot welder is shown in Fig. 1. This is a Helsby machine with overall dimensions of 36 in. and 19 in. by 46 in., and having a maximum consumption of 6 kilowatts. It is suitable for joining together iron or metal steel plates up to ·16 in. "added" thickness, this being the thickness of the two plates assembled together. The stakes or arms carrying the electrodes on this particular machine are 9 in. long, but they can also be 12 in. or 18 in. long. The machine is designed so that arms of different lengths can be used as desired. The transformer which supplies the low-voltage current is to be seen at the back of the stakes. All resistance welding machines require alternating current, and if the supply is a direct current one, a motor generator must be installed. The speed of working a spot welding machine of this sort depends entirely upon the rapidity with which the operator can place the article between the welding points and depress the pedal which brings the points together.

Erection.

In erecting a machine of this kind the first thing to do, after the metal parts have been cleaned and relieved of all rust, is to connect the transformer up to the alternating current supply, by sweating the ends of the supply leads into the thimbles at the back of the machine, which should then be earthed. This is done by connecting the end of a piece of wire to a thimble attached to one of the legs of the machine, and the other end of the wire is connected to a water-main or earth-plate. The next thing to be done is to connect up the water-pipes for cooling the electrodes. For this purpose rubber or flexible metallic tubing may be used, one length being connected to the inlet on the bottom stake and another

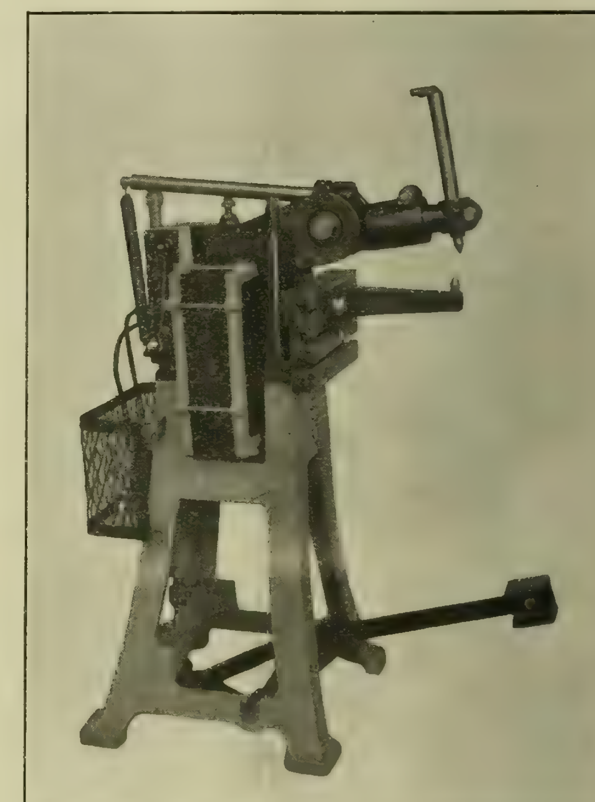


FIG. 1.—A HELSBY SPOT WELDING MACHINE.

length to the outlet on the top stake. It is also necessary to provide a connection between the stakes, but if metallic tubing is used for this purpose, special precautions must be taken to prevent the tubing forming an electrical connection between the two stakes, for this would, of course, short circuit the transformer When the machine is in operation about eight gallons of water must be allowed to flow through it per hour, in order that the welding tips may be kept cool. The welding tips are made of copper, and if not cooled will rapidly wear away.

Operation.

The method of operating the machine is to assemble the pieces of metal together, and then to clamp them between the electrode tips, this being done by holding the lower piece of metal on the lower electrode and by bringing the top electrode down by depressing the pedal. Directly the top electrode

touches the work the metal becomes white hot at the point where the work is gripped and the pressure which is applied by the foot-pedal forces the two portions of metal to unite and form a weld. As far as possible, the metal should be free from rust, scale and dirt and other foreign matter that is likely to hinder the passage of the welding current. No preparation is necessary, however, unless the metal is very dirty. The time taken to make a single weld varies from a fraction of a second to perhaps one second, but no definite time can be specified, for much depends upon the thickness of the metal, its condition as regards dirt, and the diameter of the spot made. The voltage can be adjusted to suit metals of different thicknesses by means of plugs connected to different sections of the transformer winding.

to be welded before the current is switched on, by closing the switch at the back of the machine. The pressure can easily be regulated by moving the top or bridge of the switch up and down the rod upon which it is mounted, and by adjusting it so that the electrode tips are forced well together before the switch closes. Care must be taken to see that when the electrodes touch they are directly in line with one another, for if one of the electrodes is slightly out of line with the other the weld is likely to be burnt. Directly the work is clamped between the electrodes the secondary circuit is closed, but no current flows through the metal until sufficient pressure has been produced by the foot-pedal to close the primary switch at the back of the welder, thus preventing sparking.

Various types of spot welders are made by the A. I.

Fig. 2.—A Spot Welder in Operation. (The A-1 Manufacturing Coy.)

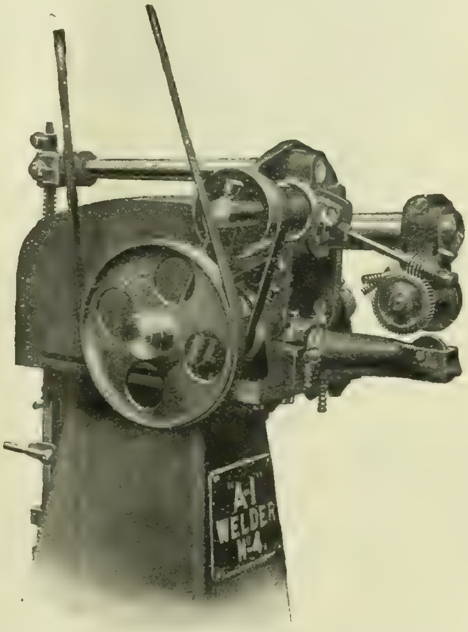


Fig. 4.—A Seam Welding attachment fitted to a Spot Welder. (The A-1 Manufacturing Coy.)

Manufacturing Company of Bradford. The smallest machine (number 0 size) is for welding brass and aluminium up to $\frac{1}{32}$ in. added thickness, *i.e.*, the total thickness of the two pieces of metal to be joined, or for welding ferreous metals up to $\frac{1}{16}$ in. added thickness. It will join iron or steel sheets of added thicknesses ranging from 1/64 in. to $\frac{1}{16}$ in., or if the machine is only used intermittently, the total thickness can be increased to $\frac{3}{32}$ in. On small articles, composed of 30 B.W.G. mild steel, that can be handled quickly; from 40 to 50 welds can easily be made per minute. In common with other spot welders, the articles or plates to be welded are put in position on the bottom electrode, and when the operator depresses the pedal the top electrode is brought down on to the work. Further pressure applied to the pedal brings the switch into action and the metal then attains the proper welding heat, and when the weld has been made the pedal is released.

Upkeep.

From time to time, the electrodes require filing in order to remove any metal that may have adhered to them, and to enable this to be done the electrodes are constructed so that they can easily be removed. Three types of electrodes are made for use with these machines—concentric, eccentric, and flat electrodes. The concentric type has the welding point in the centre, and an eccentric electrode a point a little way out of the centre. Concentric electrodes are mainly used, but they demand a maximum amount of clearance around the weld, and for welding in corners and other awkward places the eccentric type of electrode is employed. The flat electrode may be used either with a concentric or eccentric tip. All the tips are interchangeable and suitable for either top or bottom stakes.

An important point that should receive attention is to see that a fair pressure is applied to the surfaces

A six-way switch is provided for altering the transformer voltage so that the best weld can be obtained on any particular class of work. The top and bottom arms fit into round sockets, thus enabling them to be twisted to the right or left, with the result that they can get into awkward places. The standard arms are fitted with $\frac{5}{8}$ in. diameter hard-drawn copper conical shaped electrodes, with a slight flat at the extreme tip to give the required diameter of the welding spot, but for work demanding special electrodes the $\frac{5}{8}$ in. diameter rod can be shaped to suit the requirements.

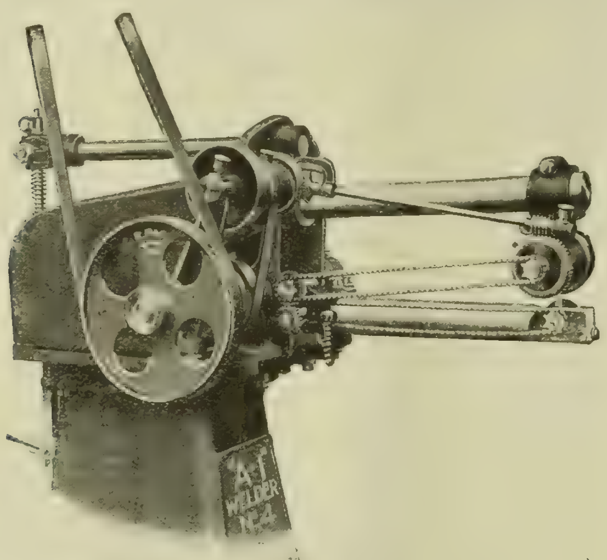


FIG. 3.—A SEAM WELDER.

The welders can be fitted with solid top and bottom arms, and 1 in. diameter water cooled electrodes fitted with renewable tips, but if it is required to use the machines for special work either of the arms can be water cooled in the manner first described, the other arm having a water-cooled tip. Usually the machines are made with 12 in. arms, but they can be of various lengths and shapes according to requirements.

The maximum amount of energy required by the smallest machine is three kilowatts. The firm's next size spot welder is suitable for brass or aluminium up to 3/64 in. added thickness, and ferreous metal up to $\frac{1}{8}$ in., the thickness being the total thickness of the two plates in each case. The maximum energy consumed by this machine is four kilowatts. Another machine will join iron and mild steel plates having an added thickness ranging from 1/64 in. to $\frac{1}{8}$ in., and the maximum energy consumed is six kilowatts. If the machine is used intermittently it can deal with metal having a total thickness of $\frac{3}{16}$ in. A machine, designated No. 3, is also made for welding ferreous metals up to $\frac{3}{16}$ in. added thickness, but if the machine is used intermittently the thickness may be increased to $\frac{1}{4}$ in. The total thickness for brass and aluminium is $\frac{1}{16}$ in., and the maximum energy consumed is six kilowatts. On another machine (No. 4 size) 24 in. stakes or arms are used, but 36 in. arms can also be fitted if necessary. This machine will weld ferreous metals up to $\frac{1}{4}$ in. added thickness, and up to a $\frac{3}{8}$ in. thickness if used intermittently. The thickness for brass and aluminium is $\frac{3}{32}$ in. Three other spot welders are also made by the firm, the largest being suitable for joining iron and mild steel sheets ranging from $\frac{1}{16}$ in. to $\frac{3}{4}$ in. added thickness, or up to $\frac{7}{8}$ in. if used intermittently. One of the A. I. company's machines is shown on Fig. 2.

Seam welding is a development of spot welding, and is particularly advantageous when a tight joint is required on cans and so forth. Seam welding, however, is limited in its application to fairly thin metal, and it cannot be applied to aluminium. Seam welders differ from those used for spot welding, in that the joint is made by means of rollers. In the case of the seam welders made for thin metal by the A. I. Manufacturing Company, the upper roller electrode is power driven, whilst the lower roller is driven by friction, but in the case of the machines for heavier gauge metal both rollers are power driven, as shown in Fig. 3. Coned pulleys are provided in order to enable the operator to obtain various speeds, and these pulleys are either driven from the main

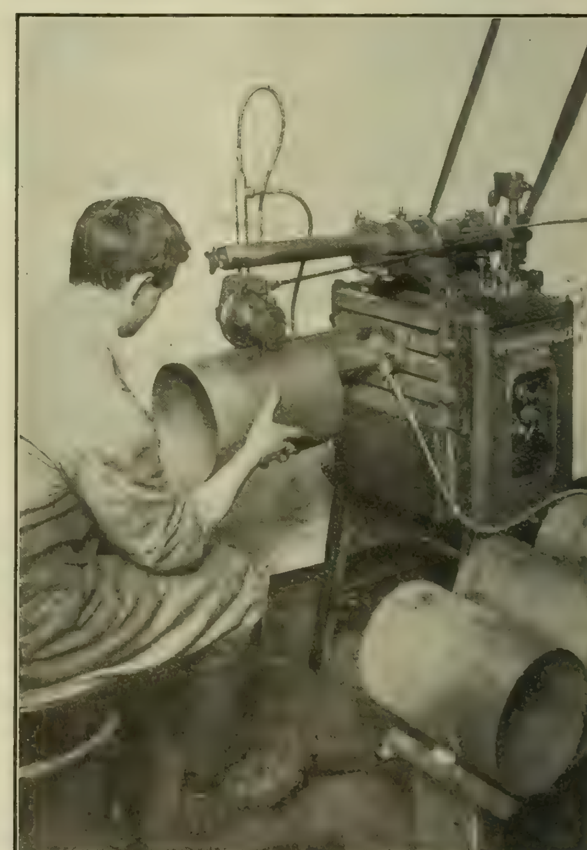


FIG. 5.—A MARRYAT AND PLACE SEAM WELDER.

shafting or from a small independent electric motor, and a clutch enables the machine to be started at will. The materal to be welded should be reasonably clean on the edges, and this condition may be obtained by sand blasting or pickling. The sheets to be welded are overlapped by about $\frac{1}{16}$ in. or more according to the thickness of the metal. The overlapping edge of the joint is then placed under the upper electrode and the pedal of the machine is depressed, thus bringing down the upper electrode and making a spot weld at the starting point. The operation is then

repeated at intervals of, say, 6 in., along the line to be welded, thus making a number of spot joints, and this operation is known as "tacking." After the metal has been subjected to this treatment the clutch is put into action, and the metal seam to be welded is passed between the rollers whilst the pedal remains depressed, so that the revolving electrode rollers are kept in continuous contact with the metal, which is automatically drawn along in the desired direction. The moment the end of the seam is reached the pedal which applies pressure to the rollers is released when the weld is complete. If the job is finished and the next piece of metal has to be "tacked" in the manner described, the clutch is released, but if the weld has to be continued further on the clutch is left in action. The design of the roller electrodes is varied to meet special requirements, and automatic revolving feeds can be applied.

Seam welders are made by the A. I. Manufacturing Company for various classes of work. The company's S3 seam welder will weld brass up to $\frac{1}{32}$ in. added thickness, and mild steel up to a total thickness of $\frac{3}{32}$ in. The speed of operation naturally depends upon the thickness of the metal. Two pieces of No 30 S.W.G. metal can be welded at the rate of $10\frac{1}{2}$ ft per minute, and No. 16 S.W.G. metal at the rate of $5\frac{1}{2}$ ft. per minute. Four speed cones are provided to give a good variation in speed to suit the range of the machine. On the front of the pedestal a switch is fitted, and this switch gives five distance heating speeds and also enables the current to be completely cut off when necessary to enable the operator to make adjustments. The top arm carrying the driver roller is hinged at the welding level of the bottom roller so that a straight and direct pressure is applied to the weld. Moreover, the top and bottom arms fit into round sockets, thus enabling them to be quickly withdrawn if other stakes are all required for the work in hand. The top arm is not usually water cooled, but the bottom electrode and its roller are supplied with a constant flow of water. These electrodes are longitudinal seam welding, but special circular electrodes are provided for use in connection with the welding of the bottoms of cans, etc., and in this case both electrodes are water cooled. The maximum amount of energy required for the S3 seam welder made by the A. I. Manufacturing Company is six kilowatts. The company supplies seam welding attachments, as shown in Fig. 4, for spot welders, and can be applied to the Nos. 3, 4, and 5 size spot welding machines, so that if it is occasionally necessary to do seam welding these special attachments can be used. The company's S4 seam welder will join brass up to $\frac{1}{16}$ in. added thickness, and mild steel up to $\frac{1}{4}$ in. thickness, that is to say, the combined thickness of the two pieces. Two pieces of No. 30 S.W.G. metal can be welded at a speed of $10\frac{1}{2}$ ft. per minute, and two pieces of No. 16 S.W.G. metal at a speed of $5\frac{1}{2}$ ft. per minute. Another machine, designated No. 26/4, is a longitudinal seam welder suitable for drums, etc., and this will also deal with iron or mild steel plates having a combined thickness of $\frac{1}{4}$ in. at the speeds above specified.

A new seam welding machine recently introduced by Marryat and Place, of London, is shown in Fig. 5. The machine is designed to weld unpickled metal, and it differs from the usual seam welders in that the electrodes remain stationary during the welding period, and are only revolved to feed the work after the current has been switched off. As soon as the current has produced the fusing temperature the circuit is interrupted, whereupon extra pressure is applied to make the final squeeze, the weld being allowed to cool off and set before the work is fed forward. The electrodes are brought together by means of a pedal working against a spring in the usual manner, but the pedal mechanism is provided with a toggle and lever arm, one end of the arm carrying a roller adapted to be acted upon by a power-driven rotating cam and the other end being connected to the rod which carries a spring through which the upper eectrode is controlled. The spring rod also serves to actuate a trip switch, which switches the current on and off. The cam and trip switch are arranged to operate so that as soon as the roller electrodes are brought together and pressed on the work the current is switched on and the high part of the cam; then this raises the spring rod still further, thereby cutting off the current and at the same time giving an extra squeeze on the work. After the current is switched off the work remains stationary until the weld has cooled off and set, and when this has occurred the more gripped by the electrodes, when the current is again automatically switched on and the operation is repeated. The operator keeps the pedal depressed until the seam is finished, with the result that a series of spot welds is produced, each weld overlapping the other and forming a water-tight seam. The advantages claimed for the machine are that the electrodes are kept free from scale, the welding takes place whilst the electrodes remain stationary, extra pressure is added to obtain the final squeeze, and the metal need not be cleaned or pickled before welding.

THE FOUNDATIONS OF INDUSTRY.—II.

From a Special Correspondent.

Another Inquiry Needed.

All wealth production ought to be regarded not from the point of view of how it will benefit a few individuals, but rather from the point of view of how the best interests of the community as a whole can be served. "Since coal," as Jevons said, "is the material source of the energy of the country" and since our whole prosperity is bound up with coal in its various forms of light, heat, and power, the immediate problem that faces us is how to secure the very best return for the nation from the coal consumed. The present coal shortage in Europe has emphasised the difficulties of modern civilisation without coal, and the high price of coal in this country naturally emphasises the necessity for its more economical use. In view of the importance of this subject the Government should not be content with the reports of the Coal Conservation Committee and its sub-committees, some of which are one-sided in character, especially that on the Electric Power Supply in Great Britain. Another committee of inquiry is needed to investigate and publish the facts regarding the incidence and causes of waste, with a view to making the most efficient use of the whole of the fuel raised in the country. Following on such an inquiry, Light, Heat and Power Commissioners should be appointed who would constitute the co-ordinating link between the fuel industries.

They would concern themselves with the economic production of energy, whatever its source. They would in practice examine carefully gas production, electricity generation, and such questions as coke-ovens, blast-furnaces and boilers. When it is remembered that on the average 5 lbs. of coal are consumed per horse-power-hour in steam raising, it is clear that there must be a great and avoidable waste of valuable fuel going on in many parts of the country. We are only at the beginning of our economies in these directions.

Folly of a Hard-and-Fast View.

When I think of the possibilities of the future, I am the more impressed with the folly of the policy which would commit us at this stage to a hard-and-fast view of the respective merits of gas and electricity. Take, for example, the Coal Conservation report to which I have referred. That report lends colour to the view that electricity is to be the medium for the production of heat in the future. I should be the last to deny the possibilities of the electrical industry, but when we are thinking of coal conservation, to determine without much fuller inquiry that electricity rather than gas is to replace crude coal for all purposes is a narrow and unscientific view. It is claimed by enthusiasts, who are either biassed or ignorant, that electricity is to be not only an economical substitute for steam power, but also that it is to be an economical substitute for the open fire or furnace, for domestic or industrial uses; and the argument is founded on the assumption that super-power stations are so to cheapen electricity as to make it possible to replace all other forms of heat, light and power. My contention is, that if the main consideration be coal economy in the interests of the nation, it is a radically unsound view. I believe that an impartial inquiry on the lines I have suggested, and not on the basis of gas *versus* electricity, would show that to advocate the adoption of electricity rather than gas in all cases where crude coal is now used would mean the destruction of at least twice as much coal as would be consumed if gas were the substitute adopted.

If it could then be shown that the proposed super-stations could deliver to the consumer nearly 20 units of heat out of every 100 consumed under their boilers, instead of only 12 as at present, it would, of course, follow that the larger stations suggested would be more economical in coal consumption than the smaller ones now in operation for the production of such electricity as can be advantageously used. In that case there could, no doubt, be a considerable increase in the use of electricity without any increase in coal consumption. But it must again be emphasised that the assumption that electricity could supersede coal for everything, and in so doing conserve our coal supplies, is one which will not bear impartial examination. My view is that there is a wide sphere of usefulness for both gas and electricity—the latter mainly in the field of power—and that the solution of our problem lies in the co-operation of the two.

Objections to the Government Scheme.

The Sub-committee's Report on Electrical Power Supply contends that electricity developed at the proposed super-stations would displace individual steam plants to the extent of saving 55,000,000 tons of coal per annum on the present output of manufacturing products. We know that the production of power, including railways, absorbs 80,000,000 tons of coal per annum, and doubtless large economies could be effected in that direction. The report, however, goes on to urge that electric heating and electric cooking should in all cases be substituted for heating and cooking by gas or by coal. In this way it is stated that another 35,000,000 tons of coal would be saved out of 189,000,000 tons of coal used in "home" consumption as distinct from "export." But this is an assumption for which no adequate proof has been adduced, and which there are good grounds for believing, would not bear critical examination." Moreover, it must be pointed out that there are two great difficulties in connection with the production of electricity on the large scale suggested by some of its advocates. It presupposes the transmission of power over a very wide area, and it has been shown that the cost of distributing electricity over big distances doubles for every 100 miles that the energy is transmitted. Another point that is often forgotten is the difficulty of finding suitable localities for these super-stations, which must be near coalfields and in close proximity to a big water supply. Now, the North Eastern district of England, to which reference is so often made by the committee as a successful illustration of the super-station idea, is so favourably situated as to afford no criterion of the success of similar experiments elsewhere. You have in this area the coal beds of Northumberland and Durham, with the unlimited water suply of the North Sea near at hand. At the same time you are operating in an area closely packed with factories and shipyards and possessing a huge industrial population. Electric energy is thus developed under the most favourable circumstances, which cannot be found in equal measure in any other part of England. In the North Eastern area an electrical unit can be obtained by the destruction of 1·54 lbs. of coal, but it is probable that a super-station anywhere else but in the North East would cost far more to run, and in some districts, such as in the south of England, the cost would probably be double. The enormous saving promised of 55,000,000 tons of coal is therefore hypothetical, since it takes for granted that all small users of steam power would immediately go over to electricity, and that electricity can be supplied as cheaply in the south as in the north.

Combination not Competition.

I have stated that in my belief gas and electricity should not so much compete as combine, but what are the facts with regard to the relative cost of turning the energy contained in crude coal into gas or into electric energy? They must be considered if it is in contemplation that one is to oust the other. If you destroy 100 lbs. of coal in producing electrical energy you get in return, even under the most favourable circumstances, less than 20 per cent of the thermal value of the coal. The average over the whole country is only 12 per cent; the average for gas, on the other hand, is 72 per cent; that is to say, six times the heat value (or "thermal efficiency") of electricity. In the carbonisation of coal for the production of gas, you obtain in the best works about

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 85 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 2 10	0 15 0 20	1 2 3 2	1 10 1 12	1 17 3 22	2 5 2 4	2 13 0 14	3 0 2 24	3 8 1 5	0
1	0 3 1	8 1 11	0 15 3 21	1 3 2 3	1 11 0 13	1 18 2 23	2 6 1 5	2 13 3 15	3 1 1 25	3 9 0 7	1
2	1 2 2	9 0 12	0 16 2 22	1 4 1 4	1 11 3 14	1 19 1 24	2 7 0 6	2 14 2 16	3 2 0 26	3 9 3 8	2
3	2 1 3	9 3 13	0 17 1 23	1 5 0 5	1 12 2 15	2 0 0 25	2 7 3 7	2 15 1 17	3 2 3 27	3 10 2 9	3
4	3 0 4	10 2 14	0 18 0 24	1 5 3 6	1 13 1 16	2 0 3 26	2 8 2 8	2 16 0 18	3 3 3 0	3 11 1 10	4
5	3 3 5	11 1 15	0 18 3 25	1 6 2 7	1 14 0 17	2 1 2 27	2 9 1 9	2 16 3 19	3 4 2 1	3 12 0 11	5
6	4 2 6	12 0 16	0 19 2 26	1 7 1 8	1 14 3 18	2 2 2 0	2 10 0 10	2 17 2 20	3 5 1 2	3 12 3 12	6
7	5 1 7	12 3 17	1 0 1 27	1 8 0 9	1 15 2 19	2 3 1 1	2 10 3 11	2 18 1 21	3 6 0 3	3 13 2 13	7
8	6 0 8	13 2 18	1 1 1 0	1 8 3 10	1 16 1 20	2 4 0 2	2 11 2 12	2 19 0 22	3 6 3 4	3 14 1 14	8
9	6 3 9	14 1 19	1 2 0 1	1 9 2 11	1 17 0 21	2 4 3 3	2 12 1 13	2 19 3 23	3 7 2 5	3 15 0 15	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·08	14·16	21·25	1 0·33	1 7·42	1 14·5	1 21·58	2 0·67	2 7·75	2 14·84	2 21·92	3 1	

Weights of Lengths of Rolled Steel Sections.

Beam 18 in. × 7 in. × 85 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 15 3 16	7 11 3 4	11 7 2 20	15 3 2 8	18 19 1 24	22 15 1 12	26 11 1 0	30 7 0 16	34 3 0 4	0
10	0 7 2 10	4 3 1 26	7 19 1 14	11 15 1 2	15 11 0 18	19 7 0 6	23 2 3 22	26 18 3 10	30 14 2 26	34 10 2 14	10
20	0 15 0 20	4 11 0 8	8 6 3 24	12 2 3 12	15 18 3 0	19 14 2 16	23 10 2 4	27 6 1 20	31 2 1 8	34 18 0 24	20
30	1 2 3 2	4 18 2 18	8 14 2 6	12 10 1 22	16 6 1 10	20 2 0 26	23 18 0 14	27 14 0 2	31 9 3 18	35 5 3 6	30
40	1 10 1 12	5 6 1 0	9 2 0 16	12 18 0 4	16 13 3 20	20 9 3 8	24 5 2 24	28 1 2 12	31 17 2 0	35 13 1 16	40
50	1 17 3 22	5 13 3 10	9 9 2 26	13 5 2 14	17 1 2 2	20 17 1 18	24 13 1 6	28 9 0 22	32 5 0 10	36 0 3 26	50
60	2 5 2 4	6 1 1 20	9 17 1 8	13 13 0 24	17 9 0 12	21 5 0 0	25 0 3 16	28 16 3 4	32 12 2 20	36 8 2 8	60
70	2 13 0 14	6 9 0 2	10 4 3 18	14 0 3 6	17 16 2 22	21 12 2 10	25 8 1 26	29 4 1 14	33 0 1 2	36 16 0 18	70
80	3 0 2 24	6 16 2 12	10 12 2 0	14 8 1 16	18 4 1 4	22 0 0 20	25 16 0 8	29 11 0 24	33 7 3 12	37 3 3 0	80
90	3 8 1 6	7 4 0 22	11 0 0 10	14 15 3 26	18 11 3 14	22 7 3 2	26 3 2 18	29 19 2 6	33 15 1 22	37 11 1 10	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	37 18 3 20	75 17 3 12	113 16 3 4	151 15 2 24	189 14 2 16	227 13 2 8	265 12 2 0	303 11 1 20	341 10 1 12	379 9 1 4	

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Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 86 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 2 20	0 15 1 12	1 3 0 4	1 10 2 24	1 18 1 16	2 6 0 8	2 13 3 0	3 1 1 20	3 9 0 12	0
1	0 3 2	8 1 22	0 16 0 14	1 3 3 6	1 11 1 26	1 19 0 18	2 6 3 10	2 14 2 2	3 2 0 22	3 9 3 14	1
2	1 2 4	9 0 24	0 16 3 16	1 4 2 8	1 12 1 0	1 19 3 20	2 7 2 12	2 15 1 4	3 2 3 24	3 10 2 16	2
3	2 1 6	9 3 26	0 17 2 18	1 5 1 10	1 13 0 2	2 0 2 22	2 8 1 14	2 16 0 6	3 3 2 26	3 11 1 18	3
4	3 0 8	10 3 0	0 18 1 20	1 6 0 12	1 13 3 4	2 1 1 24	2 9 0 16	2 16 3 8	3 4 2 0	3 12 0 20	4
5	3 3 10	11 2 2	0 19 0 22	1 6 3 14	1 14 2 6	2 2 0 26	2 9 3 18	2 17 2 10	3 5 1 2	3 12 3 22	5
6	4 2 12	12 1 4	0 19 3 24	1 7 2 16	1 15 1 8	2 3 0 0	2 10 2 20	2 18 1 12	3 6 0 4	3 13 2 24	6
7	5 1 14	13 0 6	1 0 2 26	1 8 1 18	1 16 0 10	2 3 3 2	2 11 1 22	2 19 0 14	3 6 3 6	3 14 1 26	7
8	6 0 16	13 3 8	1 1 2 0	1 9 0 20	1 16 3 12	2 4 2 4	2 12 0 24	2 19 3 16	3 7 2 8	3 15 1 0	8
9	6 3 18	14 2 10	1 2 1 2	1 9 3 22	1 17 2 14	2 5 1 6	2 12 3 26	3 0 2 18	3 8 1 10	3 16 0 2	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	
Weight.	7·17	14·34	21·51	1 0·68	1 7·85	1 15·02	1 22·19	2 1·36	2 8·53	2 15·70	2 22·87	3 2	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 86 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 16 3 4	7 13 2 8	11 10 1 12	15 7 0 16	19 3 3 20	23 0 2 24	26 17 2 0	30 14 1 4	34 11 0 8	0
10	0 7 2 20	4 4 1 24	8 1 1 0	11 18 0 4	15 14 3 8	19 11 2 12	23 8 1 16	27 5 0 20	31 1 3 24	34 18 3 0	10
20	0 15 1 12	4 12 0 16	8 8 3 20	12 5 2 24	16 2 2 0	19 19 1 4	23 16 0 8	27 12 3 12	31 9 2 16	35 6 1 20	20
30	1 3 0 4	4 19 3 8	8 16 2 12	12 13 1 16	16 10 0 20	20 6 3 24	24 3 3 0	28 0 2 4	31 17 1 8	35 14 0 12	30
40	1 10 2 24	5 7 2 0	9 4 1 4	13 1 0 8	16 17 3 12	20 14 2 16	24 11 1 20	28 8 0 24	32 5 0 0	36 1 3 4	40
50	1 18 1 16	5 15 0 20	9 11 3 24	13 8 3 0	17 5 2 4	21 2 1 8	24 19 0 12	28 15 3 16	32 12 2 20	36 9 1 24	50
60	2 6 0 8	6 2 3 12	9 19 2 16	13 16 1 20	17 13 0 24	21 10 0 0	25 6 3 4	29 3 2 8	33 0 1 12	36 17 0 16	60
70	2 13 3 0	6 10 2 4	10 7 1 8	14 4 0 12	18 0 3 16	21 17 2 20	25 14 1 24	29 11 1 0	33 8 0 4	37 4 3 8	70
80	3 1 1 20	6 18 0 24	10 15 0 0	14 11 3 4	18 8 2 8	22 5 1 12	26 2 0 16	29 18 3 20	33 15 2 24	37 12 2 0	80
90	3 9 0 12	7 5 3 16	11 2 2 20	14 19 1 24	18 16 1 0	22 13 0 4	26 9 3 8	30 6 2 12	34 3 1 16	38 0 0 20	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	
Weight.	38 7 3 12	76 15 2 24	115 3 2 8	153 11 1 20	191 19 1 4	230 7 0 16	268 15 0 0	307 2 3 12	345 10 2 24	383 18 2 8	Weight.

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

80 per cent of the thermal energy, either in the shape of gas or coke and by-products. It is therefore obvious that to use all our coal for the generation of electricity for the purpose of producing heat would be to consume this invaluable source of wealth four times as rapidly as would be the case if it was gasified. In the long run this must influence prices. Speaking broadly, to heat or to cook by gas at pre-war prices was, in fact, four times cheaper than to do the same work by electricity at 1½d. per unit. No doubt super-stations would effect an improvement in the production of electricity per ton of coal, but improvements are at the same time taking place in the manufacture of gas, so that the advantage which gas has over electricity for cooking and heating will almost certainly be maintained. So far as lighting is concerned, there is very little to choose between the two forms of energy, from the point of view of coal consumption. In respect of power, while the coal consumption is not widely different in relation to power made available, electricity has some distinct advantages, especially in the ease with which it can be transmitted. If the railways, for example, could be electrified, and such a step could be shown to be profitable for the suburban services of big industrial areas, a large quantity of crude coal might be saved. Where factories were in close proximity, electricity would also come into more general use for power or lighting. This would certainly assist in making large scale production of electricity more economical.

Will the Scheme Save Coal?

I return to my main point, which is: Will it save coal? It is not a question of whether gas undertakings or electrical undertakings are going to be benefited: it is rather a question of what is in the national interest. A general impression has been created that if only we could convert our coal into electricity at these huge "super-stations" all our industrial and domestic problems would be solved, while our coal would be so economically consumed as to enable us to increase production without increasing coal consumption. Statistics do not bear out the assumption, and Sir Dugald Clerk's figures, the most recent authoritative pronouncement on the subject, although they have been challenged, have never been disproved or seriously disputed. All we ask, and all we ought to demand, is an impartial inquiry into those figures.

There is one other rather important engineering point that must not be forgotten before we discuss national finance, and that is the question of by-products. At the moment, all coal that is consumed at an electrical generating station is burnt to ash. If the coal be converted into electric energy, all the valuable chemicals produced by coal carbonisation at a gasworks are destroyed. Many of these are essential to our manufacturing industries, to agriculture, to road and aerial transport. During the war benzol and toluol were of inestimable value to our fighting forces. Experts have expressed the opinion that the recovery of these products in conjunction with the generation of electricity is not a commercial proposition—and that is a very important point to bear in mind, and emphasises the need for the further inquiry for which I contend.

COAL CARBONISATION.

Value of Low Temperature Process.

The securing of important contracts with some of the greatest industrial firms in the North for the products from low-temperature carbonisation plants once more focuses attention on the process controlled by the company bearing that name.

The Yorkshire Electric Power Co., and Steel, Peech and Tozer Ltd., are household names in the engineering world, and their adoption of this process would seem to put it once for all in the class of great ideas which have established themselves as an integral part of the industrial life of the nation. Moreover, the Sheffield Corporation has also contracted to take a supply of the company's products, and negotiations to the same end are on the point of completion with powerful Scottish interests.

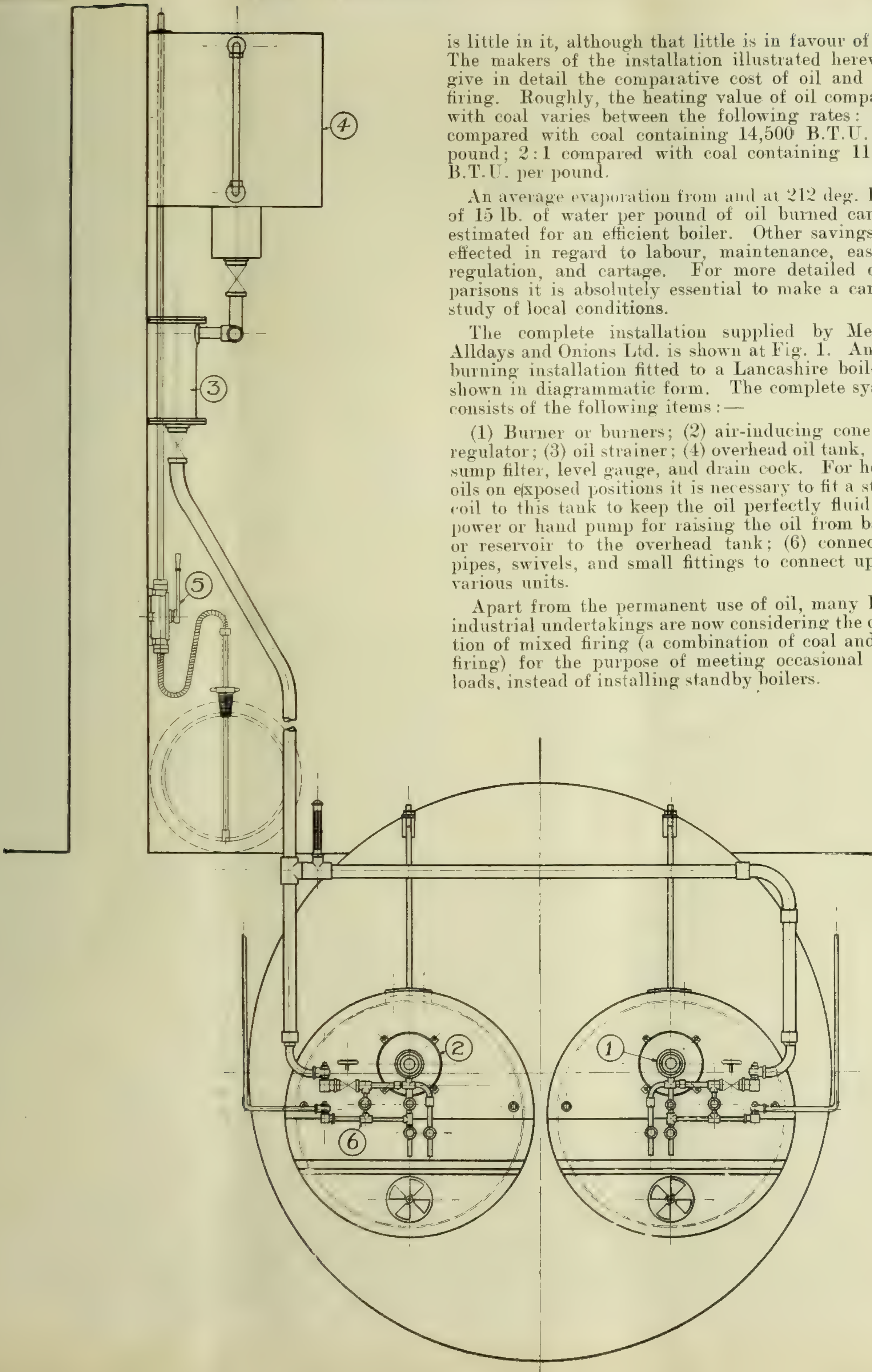
Economy in the use of coal itself and its valuable products is one of the most pressing national problems of the day. Low Temperature Carbonisation Ltd. rescues raw coal before it reaches the factory furnace, or the open domestic grate, and extracts its volatile elements, converting and refining them into motor spirit, fuel oil, sulphate of ammonia, and gas, leaving as residue a valuable solid smokeless fuel. The motor spirit produced is of the finest quality for motor cars, and the fuel oil is of the quality now in insistent demand for ships' fuel, and is up to the high specification requirements of the Admiralty. Sulphate of ammonia is in continual demand, both as a fertiliser and for explosives. Of the value of smokeless fuel it is sufficient to state that it has been proved to be worth twice as much as ordinary coal by reason of its radiant heat.

The works at Barnsley are being rapidly extended, and from this plant a large output is expected before the end of the year. A considerable portion of the machinery and plant required for at least one of the above contracts, namely, the Yorkshire Electric Power Co., has already been erected. From this plant gas is supplied to the power company and burnt under the boilers of their generating stations.

It is claimed that the process enables the most economical results to be obtained from the carbonisation of coal, and by its application the profit-earning capacity of the iron, steel, gas, electrical, and many other industries will be considerably enhanced. Numerous applications to undertake the erection of further plants are being received by the company, and there is no better way by which the industrial supremacy of this country can be maintained in the face of the increased cost of coal than by ensuring that every ton of coal mined is effectively carbonised and full use made of its products.—*Yorkshire Observer.*

OIL FIRING FOR BOILERS.

Greater advances and progress in the employment of oil fuel for boilers have been made in the United States than in this country. At the recent meeting of the National Association of Cotton Manufacturers a paper was read on this subject in which it was pointed out that oil possessed many advantages over coal firing. On the other hand, it has been recently argued that, so far as this country is concerned, there



is little in it, although that little is in favour of oil. The makers of the installation illustrated herewith give in detail the comparative cost of oil and coal firing. Roughly, the heating value of oil compared with coal varies between the following rates: 3:2 compared with coal containing 14,500 B.T.U. per pound; 2:1 compared with coal containing 11,500 B.T.U. per pound.

An average evaporation from and at 212 deg. Fah. of 15 lb. of water per pound of oil burned can be estimated for an efficient boiler. Other savings are effected in regard to labour, maintenance, ease of regulation, and cartage. For more detailed comparisons it is absolutely essential to make a careful study of local conditions.

The complete installation supplied by Messrs. Alldays and Onions Ltd. is shown at Fig. 1. An oil-burning installation fitted to a Lancashire boiler is shown in diagrammatic form. The complete system consists of the following items:—

(1) Burner or burners; (2) air-inducing cone and regulator; (3) oil strainer; (4) overhead oil tank, with sump filter, level gauge, and drain cock. For heavy oils on exposed positions it is necessary to fit a steam coil to this tank to keep the oil perfectly fluid; (power or hand pump for raising the oil from barrel or reservoir to the overhead tank; (6) connecting pipes, swivels, and small fittings to connect up the various units.

Apart from the permanent use of oil, many large industrial undertakings are now considering the question of mixed firing (a combination of coal and oil-firing) for the purpose of meeting occasional peak loads, instead of installing standby boilers.

DESIGN AND APPLICATIONS OF "HIGH-SPEED GEARING."

By M. CORONEL.

(*Continued from page 353.*)

MARINE TURBINE GEARING—GENERAL CONSIDERATIONS.

The use of turbine reduction gears for the propulsion of ships is comparatively of recent date. In 1894, the Hon. Sir Charles Parsons started experiments for the utilisation of the steam turbine for marine propulsion, and encountered almost at once the great difficulty of getting the propeller speed sufficiently high to allow same to be coupled direct to the turbine, and after much trouble and experiment the reduction gear was adopted to this class of work. Ship propulsion direct by turbines without gearing is practically limited to high-speed vessels of at least over 16 knots; for cargo and other slower running vessels they would be of no use, and the introduction of gearing must be resorted to.

Marine reduction gearing was first fitted to the s.s. "Vespasian," a slow-speed cargo vessel of about 750 S.H.P., in 1910. The success attained by this experiment opened up a new and rapid field for marine reduction gearing, so much so that from 1909 to the advent of the war a steady increase up to 125,000 S.H.P. total had been built. The war and the far-seeing policy of the War Office, who wisely saw the possibilities of turbine-driven war vessels, the building of marine reduction gearing, took a great jump, so that in 1915 500,000 S.H.P, had been built, in 1916 two millions, and by the end of 1919 more than 18,000,000 S.H.P. total were being transmitted by geared turbines for war and commercial vessels in commission and under construction, and reduction gearing is now used nearly in every class of ship with power ranges from 500 S.H.P. to 50,000 S.H.P. per shaft up to 100,000 S.H.P. per ship, 25,000 S.H.P. per single gear, 15,000 S.H.P. through one single pinion, and the total horse power transmitted by geared turbines for commercial work alone is about 1,400,000 S.H.P.

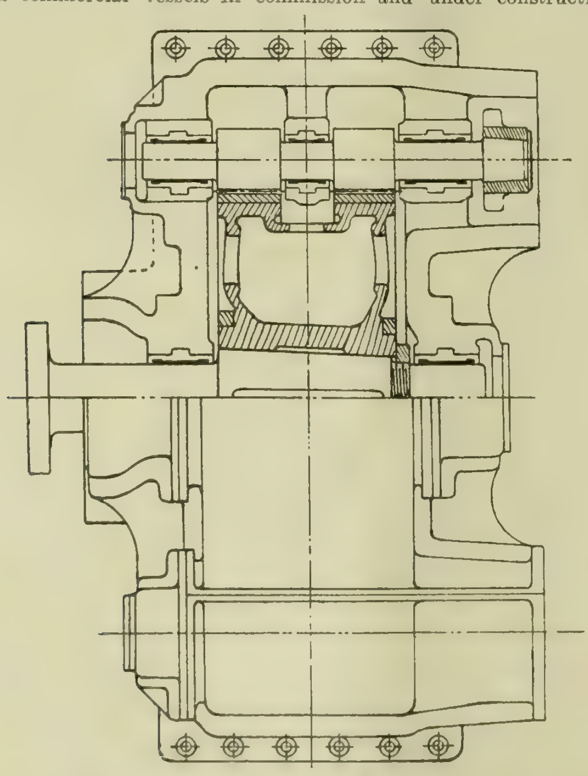


FIG. 18.

Efficiencies as much as 98 to 99 per cent can now be obtained by modern efficiently made marine reducing gears. The type of reducing gear to be employed on ships has a most intimate connection with the rest of the machinery and the conditions under which the ship has to be put in commission. Sometimes ample space can be provided for the turbines and their reduction gears; very often, however, the available space is far below of what the reducing gear designer should like. From this various types of reducing gears have been evolved, of which Figs. 12 to 17 give some examples; they are only typical arrangements, and are views looking aft. Fig. 12 is the usual arrangement as applied to single-screw vessels with single reduction gears, and can be adopted for vessels with twin screws, if the beam allows such. The casing is split into four castings, the bottom casing in one, the top casing in three pieces about at the interference between the pinions and wheels. Fig. 18 shows also plan view of such a gear. If the weight is a consideration in design, the bottom casing may be made of light steel plating. In cases where the necessary space is not available, an arrangement, as shown in Fig. 13, is adopted. In this case the pinions are enclosed in a light detachable cover and the casing split up into three horizontal parts with additional covers for the pinion bearings. The bearing loads are then transmitted through the top portion of the gear case, which has to be made strong enough to carry these. The arrangement is more costly than under Fig. 13. Fig. 14 shows a typical double reduction gear with all the pinions and wheel

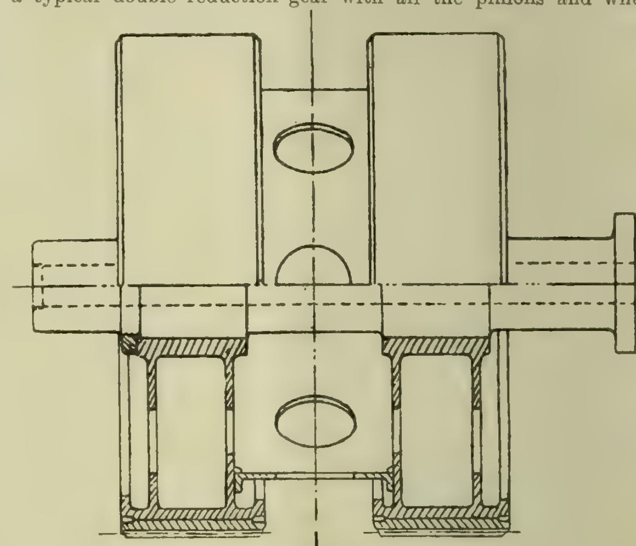


FIG. 19.

centres in one plane. Fig. 23 shows a plan and with cover removed of such a gear. These gears can only be used for small units, as they take up too much beam width; they are easy to machine and very accessible, but for large units the arrangement becomes cumbersome, and it is necessary to split the bottom half of the casing for casting and handling purposes. In such cases Figs. 15 and 16 show the more usual arrangement. In large installations of geared turbines, where economy is specially required, the turbines are split up into three units—high pressure, intermediate pressure, and low pressure. If the engine room allows the high pressure and intermediate pressure to be arranged in tandem, the gears follow the design of Figs. 15 and 16, but if this is not possible on account of lack of space, three pinions are necessary and are arranged, as shown in Fig. 17. Fig. 2 gives a photographic view of a double marine reduction gear, as also Fig. 25, which consists of a combination of two single pinons, single reducing gears acting upon a double pinion, single reducing gear. The high-pressure turbine is fitted on one side, the low-pressure and reversing turbine on the other side. The arrangement is used for Class N cargo vessels, and particulars can be found in Table VI. Fig. 26 is an end view of such a gear looking aft.

DETAILS OF SINGLE REDUCTION MARINE GEARS.

Due to the great variety of vessels, which use marine reduction gears and the fancy of shipbuilders, shipping companies, and others, a great many designs have recently been got out. There is, however, a tendency to arrive at some more or less standard design, and in years to come the number of designs will be considerably cut down. Fig. 18 gives a typical single reduction gear half plan on joint, half plan on cover, fitted with centre pinion bearings. If the pinion bearings are only two in number, the wheel takes the form of, as shown in Fig. 21 and 22.

The most interesting features in a marine reduction gear are the design of the gear wheel, the arrangement of the pinion shaft, and the manner in which the casing is split up. The turbine is coupled to the gear by means of a flexible claw-type coupling; for calculating purposes about 390 lb. per square inch is allowed on the flanks of the teeth of the coupling. All the units have a limited free movement in a fore and aft direction.

The pinions are made from a solid forging of ·4 per cent carbon to ·7 per cent steel with about 3 per cent nickel. The pinons are not usually made less than 5 in. P.C. diameter, and the speed of the pitch line is about 4,000 ft. to 6,000 ft. per minute. The centre pinion, when fitted, should be about 40 per cent of the total bearing length. The pinion bearings are made of cast iron or cast steel, lined with white metal, and the bearing pressures vary from 90 lb. to 140 lb. per square inch, according to the size

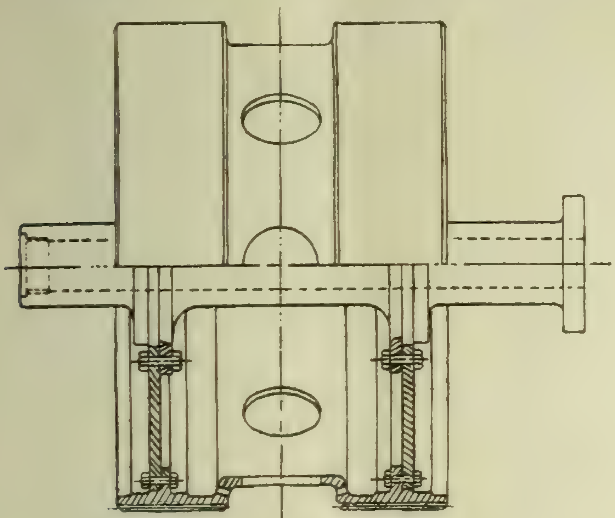


Fig. 20.

of bearings. Pinions of 18 in. diameter and above, transmitting high power, are sometimes made with two loose sleeves. The sleeves are shrunk on and pegged in the same manner as the main wheel shrouds (see Figs. 19, 21, and 22). The shaft is then very often made of mild steel. If it is desirable to keep down the weight in the latter, a hole not exceeding 60 per cent of the journal diameter may be bored right through the shaft, the ends of which are plugged with mild steel screw plugs. The relation between pinion diameter and the overall length of same is such

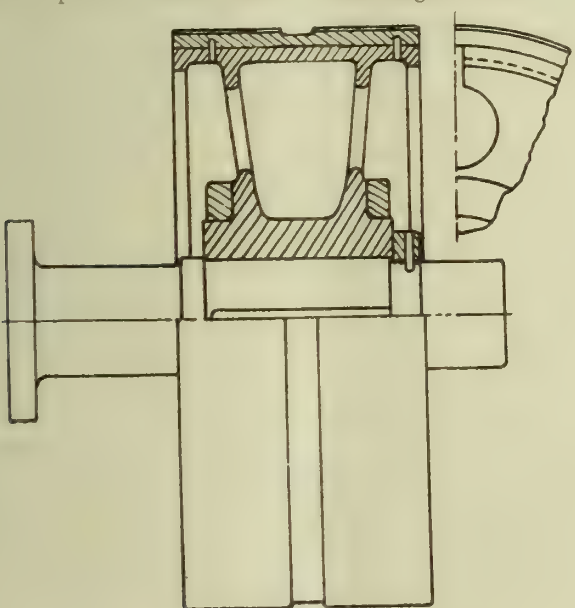


Fig. 21.

that the maximum deflection is kept within reasonable limits, this being largely a matter of practice with various designers. The deflection may be found by constructing the usual deflection diagram (see the author's article in *The Practical Engineer* for September 25th and October 2nd, 1919), or can be calculated. The distortion of the pinion is made up of two items, viz., twist of the pinion due to the torque and the bending due to the pressure on the teeth. In the case of the former, the torque T at any point of the pinion at a distance x from the driving end bearing is

$$T_x = \frac{p x d}{2} = \frac{2 f I}{d} = \frac{\pi f d^3}{16}$$

when f = sheer force at circumference of pinion in pounds.
I = moment of inertia for twisting.
d = pitch line diameter in inches.

The allowable distortion should be kept very small, and in the best designs does not exceed $\frac{1}{100}$ in. By pinions with centre bearing the bending stress is generally low and does not receive in that case consideration, but in cases without the third bearing undue bending may be observed and should be duely calculated.

The design of the main wheels presents, as stated above, the most interesting feature in marine gearing design, and considerable ingenuity has been shown and is required to often build up a wheel, which fulfils all the requirements of weight stiffness and size called for in the design. Cooling stresses in cast-iron wheels call for special attention.

Wheel designs may be classified under two headings : Type (a), wheels built up from steel plates and steel castings or forgings;

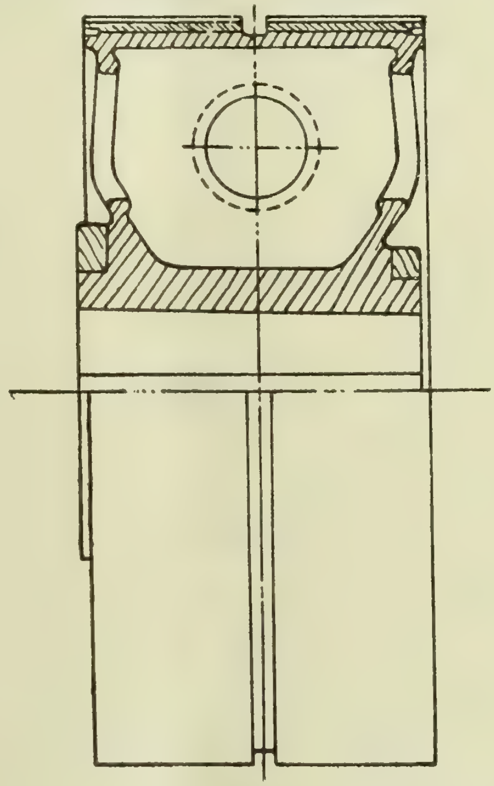


Fig. 22.

type (b), wheels with a cast-iron centre and forged steel rim or shroud shrunk on and pegged to centre. All wheels fitted to Admiralty work are made to type (a), the general features of which are shown in Fig. 20. The rim and distance piece are made, in this case, in one solid forging of high quality steel or nickel steel ·2 per cent on which the helices are cut (see Fig. 27). The wheel sides, connecting the rim to the shaft boss, are made of mild steel boiler plate. They are securely bolted to the rim and to collars forged solid with the shaft, forming the boss of the wheel. The wheel shown in Fig. 19 is suitable for a high-class merchant ship. Although of the type (a), it differs in some respects from same described above. The distance piece and the wheel centres are all made of cast steel. The shrouds are steel forgings, shrunk and pegged to the centres. The distance piece which connects the two halves is bolted to them. The whole is keyed and shrunk on shaft secured by a nut which is pegged to wheel boss. These special wheels are only used where weight and a light design are imperative. They are very expensive owing to the intricate nature of the forgings required and the extra machining necessary.

Wheels of type (b) design, Figs. 21 and 22, are fitted to all gearing for ordinary merchant ships. Three designs are shown in Figs. 21, 22, and 18; the first two are used when no centre

pinion shaft bearing is necessary. In Figs. 18 and 22 the shouds or rims are made in two forgings, while in Fig. 21 the helices are cut in opposite direction on one forging (see also Fig 27), which shows, however, a rim when using a centre bearing. As stated above already, all turbine gears are now cut with the hobbing process, the wheels on vertical milling machines without or with Parsons' "creeping" motion, as described and illustrated before; the pinions sometimes hobbed in a lathe, the shaft being held horizontally. A sufficient space has to be left, say, from 1 in. to 2 in., according to size of hob, to allow for clearance of hob between the two faces of the helices. A wrought-iron ring is shrunk on both ends of the wheel boss to relieve the tension in same when the wheel is pressed or shrunk on the shaft. All cast-iron wheel rims are split in four or six places at the outer edge, according to size, to relieve the strains set up in casting while cooling in the mould.

The pinion shaft is allowed a longitudinal clearance of + ·001 in to + ·003 in. between bearing and shaft collars and about ·002 in. to ·003 in. diametrically. One authority gives from $1\frac{1}{4}$ mils. per inch diameter for a 30 in. diameter shaft to $2\frac{1}{4}$ mils. per inch diameter for, say, a 6 in. shaft. The question of diametrical clearance between bearing shell and shaft is not so much a running clearance alone as to get a sufficient thickness of oil film to efficiently carry to load without the oil film breaking away in places. Little is known, however, about what actually takes place in high-speed heavily loaded bearings, and experiments are still being carried out in this direction. The pinion speeds at pitch line, for a 5-in. diameter pinion, is usually from 3,600 to 3,740 revolutions per minute. The shaft for such gears is generally made hollow, as mentioned before, the hole being usually one-half to one-third the diameter of the shaft.

The casings, as mentioned before, are split up into various sections according to what design has been adopted, compare Figs. 12 to 17. Ventilators and connecting pipes for carrying off the oil vapour, oil sight covers, inspection doors, and spring boxes are fitted, besides pressure and oil-level gauges. Thermometer pockets to all bearings to test the running oil temperature are fitted at an inclined position in the bottom casing; oil test cocks and funnels and gear pump or other pumps to be described later. The bottom casing very often is of a conical shape with an outlet branch to let off the oil (see Fig. 26). The wheels are lubricated by spray nozzles over their entire width.

(To be continued.)

SOME USEFUL IMPROVISATIONS.

Adaptability.

Whilst it is, of course, advisable to use only appliances and plant specially constructed for their respective purposes, whenever possible, there are times when the works engineer who rapidly can improvise inexpensive but effective means of carrying out repairs or executing new work is of particular value to his employers. A number of instances I have, at different times and in various types of works, noted are given below, and may suggest to other readers variations applicable to meeting their own circumstances.

Examples.

In one case a joiner in a textile mill, wishing to be able to do occasional wood turning, and being in possession only of a small, single-speed headstock as used for drilling holes in wood, made it into a lathe by roughly hewing a loose headstock out of a piece of hard wood and screwing tightly into it a "coach" or "lag" screw to act in place of the regular adjustable spindle, the pointed end of the coach screw acting as the stationary lathe centre. I have seen scores of pieces turned up in this lathe.

At another mill there was only a hand-driven bolt and pipe-screwing machine but the mechanic made it into a power-driven machine by mounting it on the bed of an old-time lathe so that a driving stud projecting from the lathe faceplate contacted with the handle of the screwing machine. Consequently, when the lathe was started, the screwing machine die-head was revolved at its proper speed, thus eliminating tedious and comparatively slow handwork.

Lathe Work.

Touching on the subject of lathe work, many of the younger mechanics accustomed to seeing lathes each of which is kept to its own specialised duty have not had the opportunity of realising the remarkable versatility of the lathe—especially when of British build—in shops where the installation of machine tools is, through various circumstances, of a restricted character. On the lathe, besides turning, a comprehensive list of other work possible to be fairly efficiently performed on it includes drilling, boring, milling, grinding, sawing, etc., and only the other day I saw a good job of keyway planing or shaping and slotting of keyways in pulley, etc., bosses carried out on the lathe. The method used was to put the shaft between the lathe centres whilst being keywayed. The shaft was prevented from revolving by being cramped in a stay or steady bracket. Though located between the centres, it was not held so tightly between them but that the lathe spindle could revolve freely. The change-wheels of the lathe, connecting the headstock spindle to the guide screw which works the saddle or tool carriage, were geared up to give the coarsest possible traverse. The shaft to be keywayed being, as already explained, prevented from revolving, it followed that, when the lathe was started and the saddle nut put into mesh with the guide screw, a tool fixed in the saddle would take a longitudinal cut along the shaft. When the cut had gone far enough, the nut was withdrawn from the guide screw, and the saddle run back ready for the next cut. A little practice enabled the workman to execute a good and fairly quick job. The slotting of keyways in the bore of pulleys, etc., was accomplished by fixing the job on to an angle plate on the lathe bed and working the lathe in the same fashion as when keywaying the shaft.

"Putting-on" Tools.

A well-worn practical joke in the engineering shops was to send the new apprentice to the stores to ask for the "putting-on tool," he of course not knowing that the function of most shop tools was confined to the removal of metal or wood. However, as a workshop official, two separate emergencies caused me to evolve both external and internal "putting-on" tools.

In the first instance, a gunmetal nozzle for an injector was accidentally bored a little too large. As the job was an urgent one, the following device closed up the bore sufficiently to allow it to be finished to exact bore. The outside of the nozzle was conical at the outlet, so a piece of flat wrought iron was drilled correspondingly conical, this conical hole being of greater length than that of the nozzle bore, which required closing in and terminating at a smaller diameter than that of the nozzle end. In operation, this device was pressed against the nozzle end by the loose headstock spindle, a little oil being placed on nozzle end, and the nozzle—held in lathe chuck—was revolved. This action quite satisfactorily compressed the metal at the nozzle end. In the other case, the old dodge—not recognised as a regularly admissible one in good practice—of

centre-popping, and thus raising up the surface of a spindle or shaft which had been finished too slack a fit in a part where a pulley, gear, etc., should be a press fit, was adapted in such fashion as to become a part of standard shop practice, enabling a distinct economy to be effected. "Bright-drawn" mild steel can be purchased more cheaply than individual users could turn shafting, spindles, etc., out of the black bar. A drawback to this bright-drawn commercial material is that, for some purposes, it—being made to standard even diameter—does not permit of gears, etc., being a tight fit on it unless the bores of gears, etc., is smaller than standard. I got over this drawback by using a standard "knurling" tool, which usually is employed for making a uniformly roughened surface on the heads of screws which are to be tightened up by finger and thumb, nuts similarly revolved, as used in adjustable-jaw wrenches, on cycle foot-rests to prevent slipping, etc. The knurling tool placed in the lathe tool post and pressed against the revolving bright-drawn material gave an increased diameter sufficient to obtain any degree of tightness desired.

It, in fact, automatically produced the exact fit corresponding to the pressure used in forcing the gear on, as the projecting superfluous metal was forced back into the shaft, a little oil placed on the surface assisting in this.

Another way in which the bores of collars, etc., can be closed somewhat is by heating the casting or forging gradually to a full red heat, allowing it to cool thoroughly, and repeating the process once, twice, or thrice, as found necessary. The cooling of the outer diameter tends to compress the metal towards the centre and thus reduce the bore. I have found this wrinkle very useful in emergencies.

INERTIA TORQUE IN CRANKSHAFTS.

(*Continued from page 292.*)

Evaluation and Meaning of Constants.

In the case of the ordinary rotating crankshaft type of engine, the form and maximum values of the curve for I are quite familiar, and are only inserted here (Fig. 1) because the actual evaluation was necessary in order to obtain the torque curve, and also for comparison with an explosion, or rather, expansion, curve. In the case of the rotary engine, however, I becomes a centrifugal tension always positive in action, that is to say, always acting along the centre line of the connecting rod in an outward direction; the form of this curve is shown in Fig. 2. This also exerts an alternating torque, so that the two cases are parallel, although the actual values of the constants are different, as is also the period of alternation, this being only two per revolution in the rotary engine as against four per revolution in the static engine.

The method of determination may not be quite so familiar to all, and therefore these are attached in the form of Appendices,

Now consider the case of a single line of parts, then in Fig. 3 the inertia force I may be resolved into two forces I.tan θ at right angles to the cylinder wall, and $I/\cos\theta$ along the connecting rod centre line. It is, of course, the component I.tanθ which sets up the rotary reaction, which is the product of the side pressure by the height above the crank centre. The inertia torque T is the moment of the force $I/\cos\theta$ about the crankshaft centre, and may be written

$$T = I/\cos\theta \times OC = I/\cos\theta \times R\sin OCN$$
$$= I.R.\sin(\theta + \phi)/\cos\theta.$$

It may easily be verified that this is equal to the reaction, as mentioned above.

Now it is shown that

$$I = W.R.\omega^2.G/12.g$$

$$\text{where } C = \cos\phi + \frac{R}{L}(\cos 2\phi + \frac{R^2}{L^2}\sin^4\phi)\ (1 - \frac{R^2}{L^2}\sin^2\phi)\ -\frac{3}{2}$$

Therefore $T = W.R.^2.\omega^2.K/12.g$
where $K = C.\sin(\theta + \phi)/\cos\theta$.

On inspection of these values of C and K it will be seen that their value is dependent only on the connecting rod/crank ratio and crank angle, and that they are quite independent of the weight of reciprocating parts, stroke, and speed of revolution;

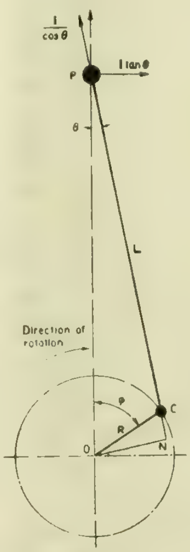


Fig. 3.

that is to say, that if we plot these curves they will hold good for every engine having the same connecting rod/crank ratio, regardless of its actual dimensions.

Also, since the torque is cumulative, as already pointed out, and since W, R, and ω will be constant for a given speed in a given engine, it follows that to obtain the value of K for any one journal we may sum the values of K arising from all the crank pins in front of it and plot curves accordingly. In Figs. 12 onwards will be found a series of curves for K plotted in this way for several of the engines referred to at the beginning of the paper. On the diagrams the numbers correspond to the number of cylinders in front of the journal to which that particular curve applies; for instance, the curve marked 2 in the four-cylinder series is that for the centre journal.

These curves are all plotted for a connecting rod/crank ratio of four to one ($R/L = 0{\cdot}25$), this being a fair average—worse than most car engines and better than most aero engines.

In this connection, see later under effect of "Connecting Rod Length."

Interpretation of Curves.

The interpretation of these curves is as follows. The ordinates represent values of K, while the abscissae represent angles of revolution, the length of each curve shown being one complete revolution (360 degrees). Therefore each time that the curve crosses the zero line it represents a reversal of load, that is to say, taking any curve in the four-cylinder series, there are four such reversals of load in a complete revolution; this means 10,000 reversals of torque (and therefore of stress) per minute at 2,500 revs. per minute, from a positive maximum to a negative maximum, of which the actual value is obtained by substituting for K in the formula already given.

Table A shows the maximum values of K for the various types of engine, while Table B shows the same figures reduced to a constant total piston area, that is to say, the values of K are divided by the number of cylinders. This assumes that the weight

TABLE A.

Values of K.

Type of Engine.	Number of Journal. 1	2	3	4	5	6
1	0·630	—	—	—	—	—
2	1·269	—	—	—	—	—
3	0·576	—	—	—	—	—
4	0·630	1·001	1·621	2·002	—	—
5		—	—	—	—	—
6	0·630	0·885	0·576	1·185	1·440	1·152
7	0·342	0·063	0·392	0·126	—	—
8						
9						
10						
11						
12	0·590	0·585	0·010	0·598	0· 95	0·020
13						
14	0·266	0·010	0·266	0·020	—	—
15	0·020	0·021	—	—	—	—
16						
17	0·342		(Vee	Twin-cylin	der 90 de-	grees.)
18	0·342	0·063	Vee	4-cylinder	90 degrees)	
19						

of the reciprocating parts per square inch of piston area is constant. This is unfavourable to the small multi-cylinder engine, but forms a useful basis for comparing the merits of the various types from this particular point of view.

This table and Fig. 4 should be particularly interesting to the devotees of the flat twin, as it shows it to be in this respect not a whit better than the much despised single-cylinder, and should be compared to the Vee 90 degree twin (No. 17 in the table). It is also interesting to compare the figures for four-cylinder No. 4 with No. 18, which is for a four-cylinder Vee 90 degree engine on a two-throw crankshaft. It will be seen that the only figures better than No. 18 are those for a radial engine with nine or more cylinders, and the twelve-cylinder types, and there would certainly be no hesitation between a four-cylinder engine and either of the latter types, more particularly amongst the class of vehicle for which the type No. 18 would be so eminently suitable, that is to say, the light car. The nett resultant reaction of this No. 18 is exactly the same as that of an eight-cylinder engine of the same capacity. The objection of uneven firing is, in the author's opinion, based on experience of a light car with a Vee twin-cylinder engine, absolutely negligible. Fig. 4 shows the maximum peaks only of a series of twin-cylinder engines and requires no further explanation, beyond a reminder that these peaks exist on both sides of the zero line.

On inspection of tables A and B, one point is shown up in a very marked degree, that is, the great superiority in respect to inertia torque of all the types having two or more lines of parts on a common

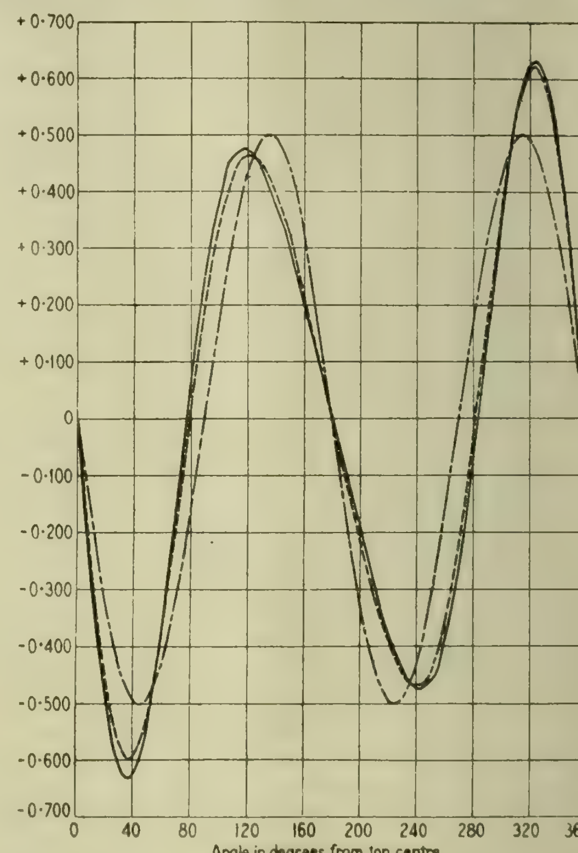


FIG. 4.

crank pin, except in the case of the very small angle Vee type like No. 9 (22½ degrees), as compared with those in which each line of parts is on a separate pin. Nos. 3, 7, 12, 14, 17 and 18 illustrate this well, quite apart from the radial engines with very many cylinders. This is a point to which it is worth giving full consideration when a new design is under discussion.

No. 18, in particular, appeals to the author for a small engine which, of course, would have no centre bearing. In this case the inertia torque and inertia reaction is only one-thirty-second of the corresponding value in the case of a four-cylinder-in-line engine of the same dimensions. If the uneven firing already referred to is considered a real disadvantage, it would make an ideal two-cycle engine using the one pair of cylinders as compressor cylinders, in which case the firing would be the same as the ordinary four-cylinder engine.

Considering the inertia torque in various engines of the same bore and stroke, we find in table A that

the highest value of K occurs in the four-cylinder engine (2·00), the next in the six-cylinder engine (1·44), and then in the flat twin with 1·26. In table B we find the single-cylinder and the flat twin running a dead heat for the position of least honour with a coefficient of 0·630, the four-cylinder engine is the next (0·500), then the six-cylinder (0·240), the three-cylinder radial (0·192), and the 90 degree twin-cylinder (0·171). Then comes another big drop to the twelve-cylinder Vee 60 degree engine with 0·050, the eight-cylinder Vee 90 degree engine with 0·049, and the twelve-cylinder broad arrow type with 0·022. It should have been pointed out that these figures refer to the worst journal.

TABLE B.

Relative Inertia Torque.

Values tabulated are K ÷ No. of Cylinders.

Type of Engine	Number of Journals.					
	1	2	3	4	5	6
1	0·630	—	—	—	—	—
2	0·630	—	—	-	—	—
3	0·192	—	—	—	—	—
4	0·157	0·250	0·405	0·500	—	—
5						
6	0·105	0·148	0·096	0·197	0·240	0·192
7	0·043	0·008	0·049	0·016	—	-
8						
9						
10						
11						
12	0·049	0·049	0·001	0·050	0·050	0·002
13						
14	0·022	0·001	0·022	0·001	—	-
15A	0·002		(9 cylinder Radial.)			—
15B	0·001	0·001	(18-cylinder Radial.)			
16A						
16B						
17	0·171		(Vee Twin-cylinder 90 degrees.)			
18	0·086	0·016	(4-cylinder Vee 90 degrees.)			
19						

When we come to the nett inertia reaction, the order is nearly though not quite the same. The figures are, single-cylinder and flat twin, 0·630, four-cylinder, 0·500, six-cylinder and three-cylinder radial, 0·192, Vee twin-cylinder 90 degree, 0·171, eight-cylinder Vee 90 degree, 0·016, and the two twelve-cylinder types, 0·002.

In the last two paragraphs only the conventional types are mentioned, Nos. 9 and 13 being unconventional angles of Vee which do not give at all good results, and of each of which there is only one example so far as the author is aware.

(*To be continued.*)

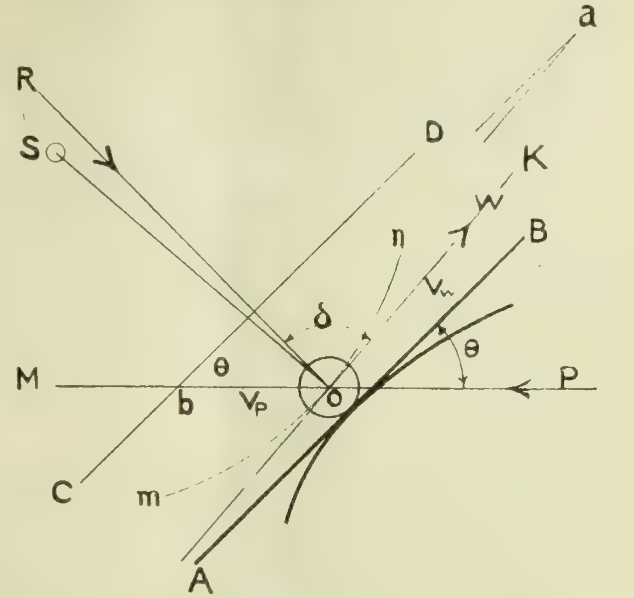
CAMS.

By W. E. Bennison, A.M.I.M.E.

(Continued from page 349.)

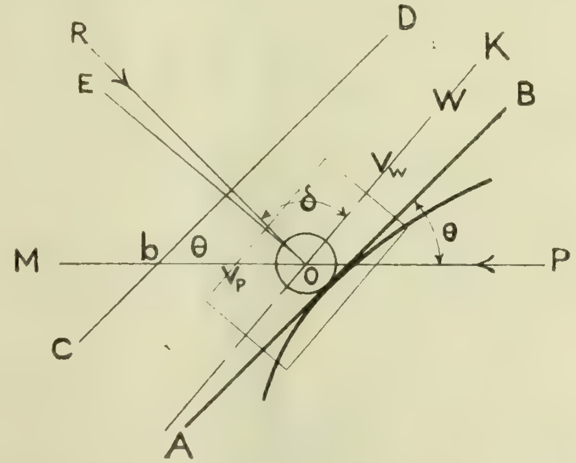
Direction of the Reaction.

It is not always easy to tell at a glance whether the conditions which have been selected or imposed will give satisfactory results. The position of the parts may be so chosen that motion will be impossible; as, for instance, when the cam angle is small and the stroke long the curve will be a steep one, and probably the follower would become locked. In the case of a simple wedge there is a limit to the angle of the wedge. The limiting condition of a screw is that the slope of the thread must not exceed the angle of repose. For a cam it is necessary to find out the direction and magnitude of the forces, as described in the third article of this series.



Cams.—Fig. 60.

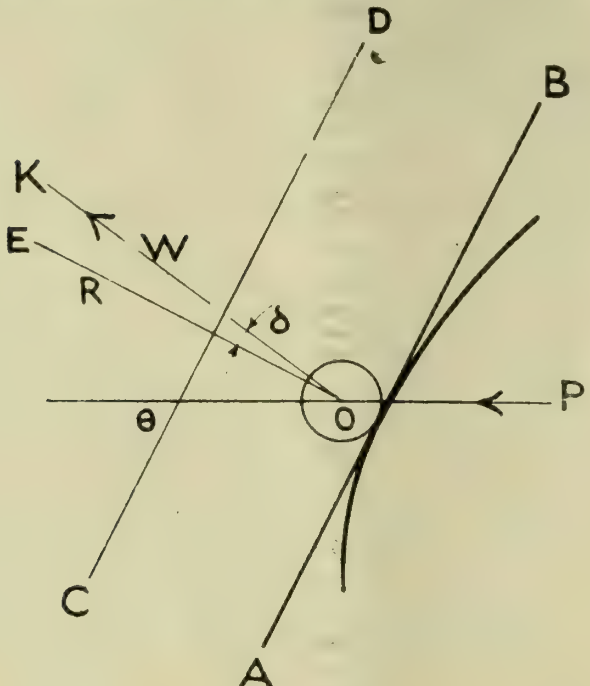
Figs. 60 and 61 show impossible conditions. In these two examples the elements are the same as in Fig. 19, page 467 (1919). O, the axis of the follower, is moving in a direction OK. AB is the tangent at the point of contact, and PM the direction of motion of the cam surface. θ is the wedge angle or slope of the curve.



Cams.—Fig. 61.

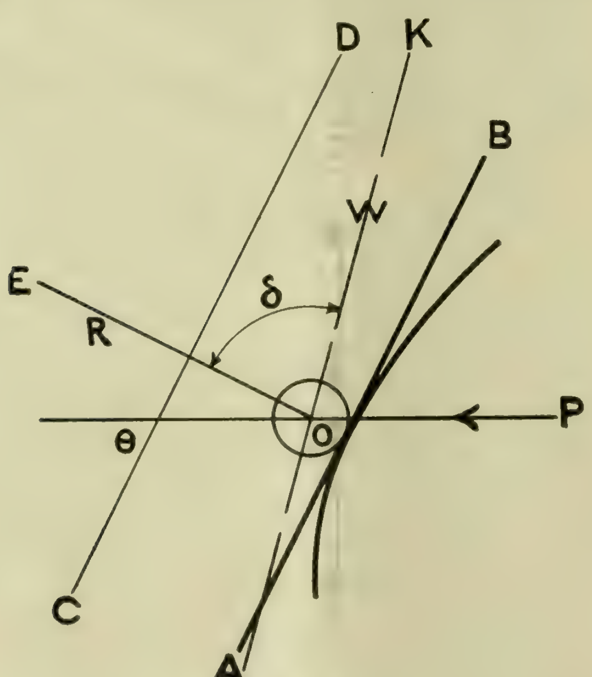
In Fig. 60 the follower is carried by a lever fulcrumed at S, and the axis O traces the arc $m\ n$; its direction at the moment is represented by OK. It will be noted that the reaction R passes very close to the fulcrum S. In Fig. 61 the follower is carried by a slide whose direction of motion is nearly parallel to AB, and the reaction is therefore nearly at right angles to OK. In both these figures, as in Fig. 19,

the line CD is drawn parallel to AB in order to construct the triangle of forces. The point a, which is the intersection of the two lines CD and OK, is a



Cams.—Fig. 62.

remote distance from O, and consequently Oa is very great compared to Ob. This means that the fraction $\frac{P}{W}$ is a large quantity, and the angle θ must therefore



Cams.—Fig. 63.

be chosen to keep this fraction within the limits. The author recommends that for roller contact the value of $\frac{\text{force}}{\text{load}}$ should not exceed 1·2, and for sliding contact somewhat less. This figure, however, should not be approached except for moderate loads and velocities. With a harmonic motion-type curve the slope at the centre may be steeper than with a uniform velocity curve.

The practicability of the conditions may often be judged by inspection if the direction of the forces are traced out as in Fig. 60. When the angle δ included between the reaction and the direction of motion of the follower is great the roller will tend to be locked and the motion be either very hard or impossible. When δ is small, motion will be produced.

It must not be thought that if the slope of the curve be great the conditions will necessarily be bad. As said before, this depends upon the position of the reaction. Fig. 62 shows a case that is quite workable, although the slope of the curve is great: the angle δ is small. The case of Fig. 63 with the same slope is bad. Here the angle δ is great.

(To be continued.)

Letters to the Editor.

To the Editor of the "Industrial Engineer."

Dear Sir,—Enclosed we have pleasure in handing you a notice from Mr. Joseph W. Shepherd, who for the past 4½ years has been the receiver for debenture holders of the Company, informing you of the termination of the Receivership, as on the 20th April, 1920.

We have, further, the pleasure of informing you that not only is the Receivership terminated, but that the debentures have been paid off, the Company's assets are free from any charge whatever, its finances have been placed in a thoroughly sound position, and we are now prepared to pay in full all debts which are owing by the Company to its creditors.

The Board and Management of the Company have been completely reorganised: Captain E. Andrew Bolton, released from service with the Royal Air Force, has been appointed Chairman of the Company; Tom Frederick Gray, who for the past four years has managed the business under the Receiver, has been appointed Managing Director of the Company; and E. A. Radford, chartered accountant, of Manchester, has joined the Board.

We shall be pleased to receive detailed statements of all amounts owing to the Company, whether in respect of the perio before the Receivership or since, and in conclusion we wish to take this opportunity of thanking our friends for the patience and consideration they have shown during the long period of the Company's difficulties and of expressing what great satisfaction it now gives us to be able to pay in full all amounts owing to them.

Looking forward to a long continuance of our past pleasant business relations with you,—We are, yours, etc.,

Bolton's Superheaters Limited.
H. Gray, Managing Director.

8th June, 1920.

[Enclosure.]

Dear Sir,—I have to inform you that by arrangement my office as Receiver and Manager of this Company ceased as on the 30th April last. The action taken in the Chancery Court of the County Palatine of Lancaster has been stayed, and the Board of the Company reorganised. The new Board are making arrangements to pay the pre-receivership creditors 20s. in the £, and the accounts owing against myself as Receiver and Manager will be discharged at due date. The Company will assume liability in respect of all contracts entered into by myself as a Receiver and Manager, which will fall to be completed after April 30th last.

I take this opportunity of thanking you for the kind assistance given to me during my receivership.—Yours etc.,

Joseph W. Shepherd,
Receiver and Manager.

Trade Items, Notes, &c.

RESEARCH IN THE MOTOR-CYCLE INDUSTRY.—The Secretary of the Department of Scientific and Industrial Research begs to announce that the Research Association for the British Motor-cycle and Cycle-car Industry has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the Association is to be registered as a non-profit sharing company, the promoters have applied to the Board of Trade for the issue of a licence under Section 20 of the Companies' (Consolidation) Act of 1908. The Secretary of the Committee engaged in the establishment of this association is Major H. R. Watling, "The Towers," Warwick Road, Coventry.

EXTENSION OF THE USES OF RUBBER.—The Rubber Growers' Association (Incorporated) offer the following awards for ideas and suggestions for extending the present uses or for encouraging new uses of Rubber :—One prize of £1,000, three prizes of £500 each, and ten prizes of £100 each, and a sum not exceeding £1,500 to be divided amongst the remaining competitors whose suggestions are considered to be of value, according to the relative value of their suggestions, but so that no competitor will receive more than £100. Suggestions must be practical and likely to increase the demand for the raw material. Ideas will be welcomed for the application in new directions of existing processes, methods or manufactures, or for improvements or new processes which will facilitate or cheapen the production of rubber goods. Competent judges (technical and otherwise) will be appointed to investigate and adjudicate upon the suggestions received.

GOVERNMENT INSTRUCTIONAL FACTORY.—The Twickenham Government Instructional Factory, which the members of the Select Committee on Pensions visited recently along with Sir Montague Barlow, Parliamentary Secretary of the Ministry of Labour, is of a special character, strictly confining its attention to the different branches of the engineering trade. The Factory is, in fact, an up-to-date engineering workshop, run on the most modern lines, and with the latest machinery. The men trained are divided into two categories—those who are admitted for a course of 13 weeks in the Factory, after which they receive a further 39 weeks in employers' workshops, and those whose period of instructional training is usually six months, which may be extended to twelve months, and who are not regarded as improvers until they have completed 18 months' training either in the Factory or in employers' workshops. The latter represent the men suitable for training as skilled craftsmen, whether fitters, turners, skilled universal millers, etc., the former the semi-skilled workmen, upon a large proportion of whom the industry is dependent. The minor machine operators (as the latter class are termed) learn to operate a single machine, whilst the skilled men have a more thorough and a more general course of training. The selection of the trainees is vested in a Technical Advisory Committee, upon which employers and employees are represented in equal proportions, and this Committee further acts in an advisory capacity on all matters relating to the efficiency of training. The training is carried out on productive lines. After a brief period of preliminary instruction, during which the men receive lessons in mathematics, the use of measuring instruments, etc., the trainee is transferred from his practical work to his machine, and learns his craft whilst engaged on the production of a commercial job. The Manager (Mr. E. Martin) accepts contracts for his Factory in exactly the same way as an ordinary commercial firm. The jobs turned out must pass the usual engineering tests. Most of the contracts accepted by the Factory are for the small parts of motor cars, and the Management, in order to get a variety of work for the trainees and avoid repetition, endeavours to secure a large number of small contracts rather than a bulk order for a single line. Some of these contracts involve more than one machine operation. One operation is performed by one trainee, and the job is then passed to another trainee for the next operation, and so on. The following gratifying letter has recently been received by the manager of the Factory (Mr. E. Martin) :—"We wish to tell you that we are very glad we started employing disabled soldiers here, and would like to say that all those men you sent us have proved most satisfactory in every way, being well trained and efficient. In particular, we would mention the last miller sent by you, who is a skilled man, and we are very pleased indeed with him. When we have any vacancies we will communicate with you and shall hope to employ some more of your trainees." It will be expected that in a businesslike factory like Twickenham, the usual atmosphere of the workshop prevails. Mr. Martin, the manager, is essentially a business man. The utmost possible consideration is given to the men in view of their disabilities, but rightly the Factory has no room for the new work-shy and the slacker. The trainees work to the clock; each job has its operation card. Bad timekeeping is dealt with by a reasonable system of deductions. The men realise that training must be taken seriously, and understand that these precautions are taken in order that conditions of training may be rendered as similar as possible to the conditions in which they will find themselves in the ordinary workshop.

Patent Applications.

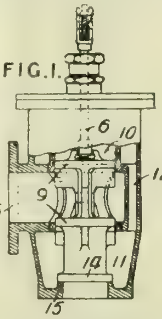
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

VALVES.

129,784.—W. and T. AVERY, J. J. BURROWS, and E. WALTERS, Soho Foundry, Birmingham.—July 13th, 1918.—A valve device, particularly applicable for use with automatic weighing-scales has a valve member adapted to give a multiple series closure. The inlet 5 is controlled by a double-beat lift plug valve 9, and

FIG. I.

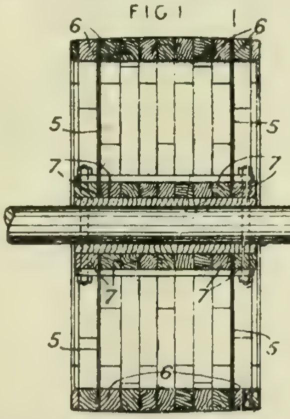


the outlet by a lift valve 14, both valves being mounted on a single spindle 6. Liquid passes from the upper chamber 10 to the lower chamber 11 through an annular passage 12, and any leakage through the plug lift valve is retained in the chamber 11 by a lip 15.

PULLEYS.

129,192.—C. H. ROE, Balm Road Mills, Hunslet, Leeds.—Nov. 11th, 1918.—In a pulley built up in halves, of the kind in which the rim 6 is composed of segmental strips of wood arranged in layers and united by spokes 7 fixed right across each half of the pulley, a ply-wood disc or discs made in halves is fitted between the rim and the spokes for strengthening purposes and for elimin-

FIG 1

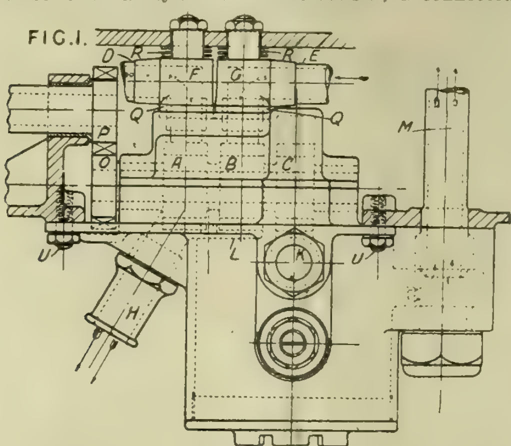


ating air resistance. The disc or discs may be situated near the centre of the pulley or spaced apart. In the construction shown, two discs 5 are employed fitted between and glued or otherwise secured to the rim and spoke sections.

LUBRICATORS.

129,316.—H. FOWLER, G. S. WILKINSON, and A. G PITT, Royal Aircraft Factory, Farnborough, Hampshire.—Oct. 11th, 1917.—A multiple pump for lubricating internal-combustion engines for aircraft etc., is formed as a unit which can be readily attached to the engne, and is provided with an oil filter and a pressure-regulating valve. One or more rotary pumps A, B drain oil from the crank case through pipes D, E and deliver it through a pipe H to a tank, and another pump C draws oil from the tank through a pipe K and forces it through a filter L to a distributing

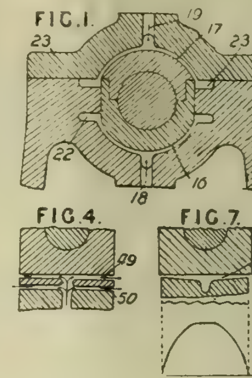
pipe M. A pressure-regulating valve by-passes the suction and delivery sides of the pump C. The pump unit is fixed to the engine body by bolts etc., U, and is driven by a pinion O gearing with a wheel P on a lay-shaft. Two elbows F, G connected to the



pipes D, E have steel spigots engaging circular ports in the pump body, and are pressed down against rubber washers Q by springs R. The joint of the pipe M is of the gland type. The pipes H, K to and from the tank have rapidly detachable rubber connections.

BEARINGS.

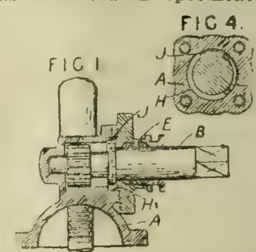
129,424.—K. BAUMANN, Northwoodhouse, Barnfield, Urmston, Lancashire, and BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., 2, Norfolk Street, Westminster.—July 8th, 1918. Bearings for shafts etc., are cushioned and adjusted by films of oil or other liquid maintained between the bearing and its supports by a continuous flow of liquid between the parts. The device is applicable for aligning toothed gearing and for distributing the tooth pressure. Clearance spaces 16, 17, Fig. 1 below and above a bearing have inlets 18, 19 and outlets 22, 23, and oil is forced through the spaces by a pump or two separate pumps which are provided with throttle or relief valves, so that by varying the oil pressure, the bearing may be adjusted vertically. In a modification, the spaces 16, 17 communicate, and the bearing is cushioned by films at the sides as well as at the top and bottom. As shown in Fig. 4, a number of parallel clearance spaces 49, 50 may be employed. The clearance spaces may be of varying width as shown at 55, Fig. 7. Stops may be provided to prevent the bearing from dropping to such an extent as to close the clearance space. Instead of using a pump, a



supply of oil under pressure may be tapped from the oil film of the journal.

VALVES.

129,955.—L. RICHARDSON, 11, Cowcliffe Hill, and J. HOPKINSON AND CO., Britannia Works, both in Huddersfield.—April 23rd, 1919.—In a parallel slide stop valve of the kind operated by a rack and pinion, as described in Specification 777/09, the rotary



movement of the operating spindle B is limited by a fixed stop G formed on the packing-gland E acting in conjunction with the known stop projection J on the spindle. The stop members are disposed in a recess H of the casing A which can be readily machined for that purpose.

INDEX TO ADVERTISERS.

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— THE —

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CONTENTS.

EDITORIAL.

THE UNSINKABLE SHIP.

THE improvement of life-saving apparatus and mechanism is important but subsidiary, and safety at sea depends primarily on the perfection of the design and construction of ships. That the unsinkable ship is not yet a practical proposition was the opinion of the Conference of Naval Architects held recently at Liverpool. The designer has to remember that building a ship is a commercial proposition, and economic conditions have to be considered. This is a policy not actuated solely by business interests, but it is in harmony with the desires of the community. It is true when a great sea catastrophe occurs there is a public outcry for the maximum of safety, but at other periods the demand is for cheap commodities and travel, and exceptional and expensive precautions against rare risk is not approved. If risk was entirely eliminated, and it is unlikely that it ever will be, it could only be done, as Sir Westcott Abell pointed out, by a great reduction of carrying power.

On what line may we expect progress in internal ship design likely to proceed? Legislation has invariably been of a hasty, ill-considered kind, based on an abnormal and particular accident, and designed to prevent the recurrence of such an accident, or the loss of life consequent on such an accident, in the future, and has touched but lightly principles of design. During the recent war it was manifested over and over that no bulkhead system was proof against the effect of a mine or torpedo explosion, but it was also found when the explosion was local and watertight doors were shut that the ship would remain buoyant. It has also been demonstrated many times that when without warning, subjected to the strains consequent on collision, watertight doors cannot be shut. This is the more remarkable, as watertight doors can be shut instantly either singly, altogether from the bridge, or automatically when the water reaches a certain level, but it appears to prove the contention of those who hold that the perfecting of the present system of bulkheads and watertight doors is more important than the evolving of freak designs which are not only unsinkable but unpractical.

In the near future welded joints will probably displace riveted joints for ships' plates, and this modification of construction may be more important as a safety factor than is at present realised. The idea of the double skin is crude and unscientific. It may prove effective up to a point, but it is a confession of failure on the part of ship designers; the logical significance of the double skin is that if a ship had three or four skins it would be quite safe. Apart from considerations of workmanship and the quality of material used in construction, there is room for research to discover a really practical design of ship that can be economically built, that will not increase the cost of transport and travel, and will combine with these qualities the maximum degree of safety.

THE ANALYSIS OF GEAR VALVES.

By A. HOULSON.

The Stephenson Link Motion.

In this article we shall consider a method of studying the movements of valves actuated by link motions, or radial gears, and the effect of these movements on the steam distribution in an engine.

Fig. 1 illustrates a Stephenson link motion. OF is the forward eccentric, and OB is the backward eccentric. F*f* is the forward eccentric rod, and B*b* is the backward eccentric rod. The slot link Z is provided with a block carrying a pin H, which gives a horizontal motion to the valve rod and valve S, and is suspended at point J by a suspension link JK which is carried by a lever KL. This lever is rigidly held in position by the reversing gear, until the necessity for gear changing (notching up) arises, consequently the point J moves in an arc of a circle described from centre K with radius KJ. The arrangement shown in Fig. 1 is known as crossed rods. The engine runs over, or, in other words, the shaft revolves in a counter-clockwise direction: therefore, in full forward gear the link will be pulled down into the position shown in Fig. 2. The slip of the block in the link will then be very small, as this slip is always least near the point of suspension J.

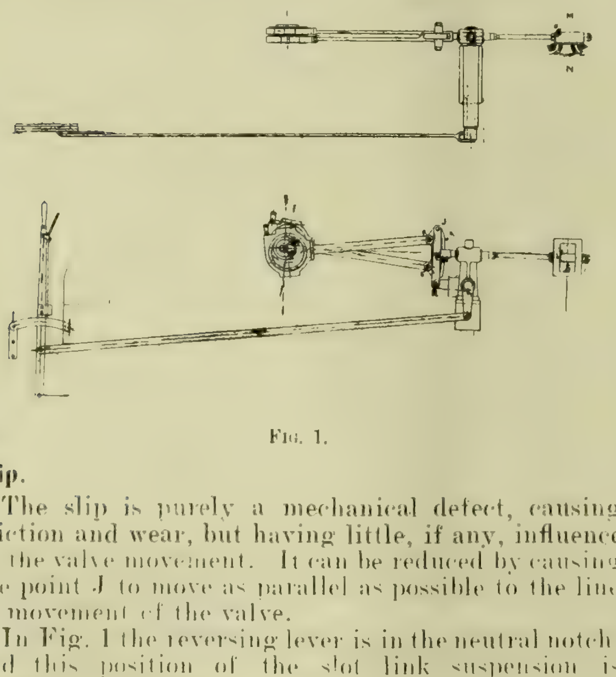


FIG. 1.

Slip.

The slip is purely a mechanical defect, causing friction and wear, but having little, if any, influence on the valve movement. It can be reduced by causing the point J to move as parallel as possible to the line of movement of the valve.

In Fig. 1 the reversing lever is in the neutral notch, and this position of the slot link suspension is termed "mid gear."

Gear Movements.

There is no port opening in mid gear, and the engine will consequently stop running when the reversing lever is pushed over into the neutral notch. Fig. 2 shows the gear in full forward gear. The forward eccentric mainly controls the slot link, and the valve gives a maximum port opening, the engine running over.

Two positions of the slot link are shown in Fig. 2, the upper position with the crank on the outer dead centre, the lower position with the crank on the inner dead centre. In the upper position the valve has opened the front cylinder port by an amount which is termed the lead. In the lower position the valve has opened the back cylinder port by an amount also termed lead. The leads may or may not be equal, and frequently a compromise is effected whereby in one particular notch, which is generally that notch corresponding to the working load of the engine, the cut-off periods for both ends of the cylinder are nearly equal. In Fig. 2 the travel of the valve between the upper and the lower positions is equal to

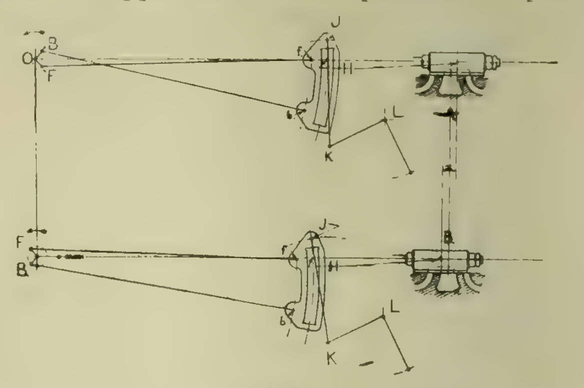


FIG. 2.

the distance X. The centre line AB through the centre of the cylinder port face divides X into two parts, the right hand being lap + lead front end, and the left hand part being lap + lead back end. To obtain a complete representation of the travel of the valve for this notch it is necessary to show the slot link in several additional positions. The following method may be used to avoid drawing the whole gear for every position of the valve.

Valve Positions.

Select any two points F and B on the circumference of the eccentric travel circle, keeping B ahead of F by the angle BOF as was done in Fig. 2. With centre K and radius KJ describe an arc J, with centre F and radius F*f* describe an arc *f*, and with centre B and radius B*b* describe an arc *b*. If a tracing of the slot link is now made, and placed so that the centre *f* of the forward eccentric rod pine lies on the arc F, the centre *b* of the forward eccentric rod pin lies on the arc *b*, and the centre J of the suspension link pin lies on the arc J, the tracing being pricked at the point H where the curved centre line of the slot link cuts the horizontal centre line of the valve spindle which is attached to the slot link at the point H, the latter point represents one position in the travel of the valve (see arrows). The other points F and B on the eccentric travel circle are taken in a similar manner, and thus the whole travel of the valve for this particular position of reversing lever is represented by a series of points H on a horizontal line. These points H may now be transferred to the diagram Fig. 3, and set off vertically above and below the base lines 50—50. If the travel of the valve is to the right of the centre line AB (Fig. 2) the distance should be set off upwards in Fig 3, and if the travels are to the left of AB the distances must be set off downwards. In this manner the curve marked 1 in Fig. 3 is obtained representing the travel of the valve in full forward gear for one revolution of the engine.

The two positions of Fig. 2 will be recognised, the upper position being shown again in the centre of

the chart (marked "O—in-stroke") and the lower position is represented at the extreme left hand end of the chart (marked "O—out stroke.") They are also marked respectively "Admission in," and "Admission out."

The other events in the cycle of movements of the valve for this notch are shown plainly on the chart by means of a sketch of the valve, and the technical term for the event marked close to the intersection of the curve S with a line through the valve. The

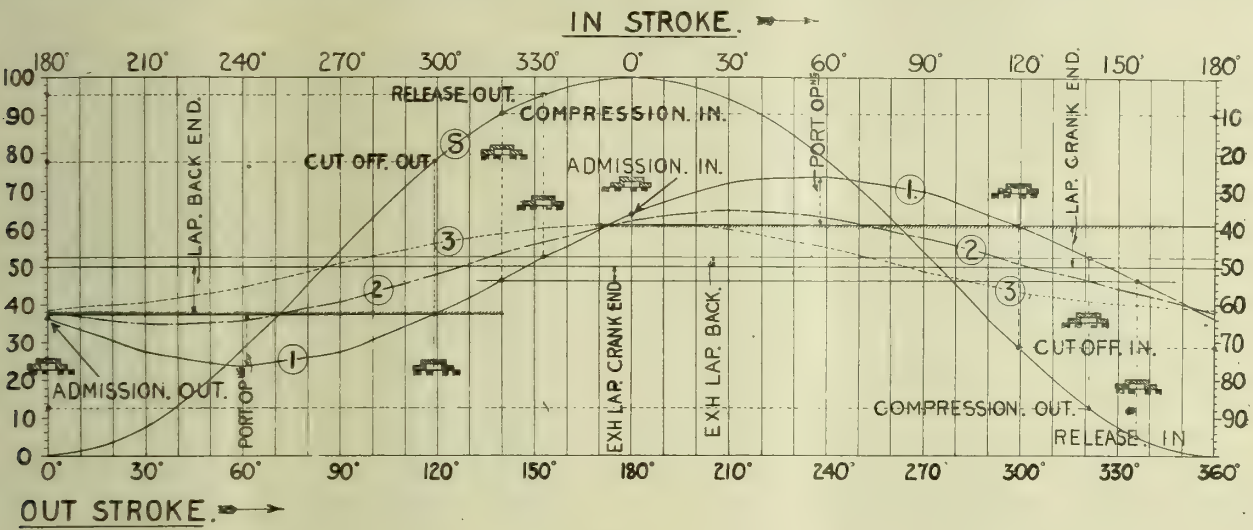


FIG. 3.

sketch of the valve shows the latter in the position it occupies over the cylinder ports when the particular event it represents is taking place, and the line through the valve has been made to coincide with the actual line determining the period at which that event takes place. This determining line is easily found.

Point of Cut-off.

If we desire to know at what point in the out stroke cut-off takes place—that is what percentage of the out stroke is covered by the piston before the valve closes the port and cuts-off the steam, we must observe that the back-end lap has been set-off downwards from the base line 50—50, and the reader should also note where the curve 1 intersects this lap line, and a perpendicular upwards should be drawn at this point. The intersection of this perpendicular with the curve S is marked "cut-off out." A horizontal line must be drawn from this latter point to the scale at the left hand end of the diagram, and the answer 77½ per cent of out stroke is obtained. The curve S, as has been shown, gives the travel of the piston from the end of the stroke for any given crank angle. It may be plotted from standard tables. By carefully studying the chart or diagram, the various events of the cycle are readily understood. Curves 2 and 3 have not been detailed out on the chart; inspection of curve 3 (mid gear), however, shows that there is no port opening for the mid gear. Curve 2, which represents the working notch gives fairly equal cuts-off. In the drawing curves 2 and 3 the centre line AB in Fig. 2 has been adhered to as the datum line corresponding to the datum line 50—50 in Fig. 3.

Walschaert Gear.

An outline arrangement of the Walschaert gear which we shall now consider, is shown in Fig. 4. The centre of the crankshaft is at O and OA is the crank. The eccentric E is connected by a rod EF to an oscillating link GF. The motion of the eccentric causes the link GF to oscillate about its centre H. A link JK is attached to the main cross head of the engines by a pin J, and a swinging link KLM is pinned to the link JK at K and to the valve rod at M. On this link is a pin L to which is attached one end of a radius rod LNP. The pin P in the other end of this radius rod carries a block which slides up and down in the curved oscillating link GF. This radius rod is suspended from the reversing link QN by a pin N. The reversing link QN is pinned to the weigh shaft lever WQ by a pin Q. When the reversing lever R is moved into another position, the link QN is lowered, and the point P takes a lower position in the curved slot, thus altering the gear.

Setting out the Valve Motion.

The motion of the valve is developed in the following way. A number of equidistant points E are

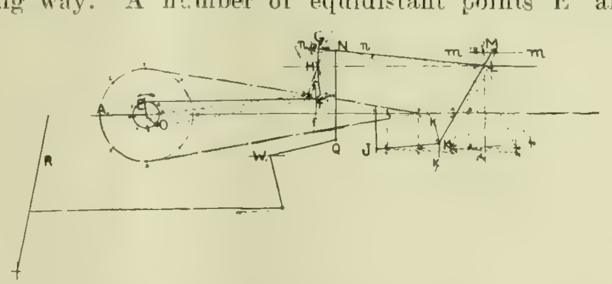


FIG. 4.

marked off on the eccentric travel circle, the angle AOE being kept constant. Thus for any position A of the crank, we have a corresponding position of the eccentric E. With centre E and radius equal to the length of the eccentric rod EF the arc *ff* is described, and with centre H and radius HF an arc is described which cuts the arc *ff* in F. This fixes the position of the link for the given position of the eccentric. A tracing of the link with the points H and F marked on should be placed on Fig. 4 so that the points H

falls on the centre H and F falls on F, and this tracing is pricked so as to form the curve GF on Fig. 4.

The position of the point J on the main cross head for the given position of the crank has to be fixed up from the crank and connecting rod drawings. With centre J and radius JK the arc KK is described, and with centre Q and radius QN the arc *nn* is described. A template of the two links MK and LP may be made out of thin wood with a well-fitted pin joint at L. The ends M, P and K are formed as pointers, and a transparent celluloid or tracing cloth window should be inserted at N with a fine hole to mark the centre. By placing the template on the drawing Fig. 4, the point K being on the arc KK, the point N on the arc *nn*, the point P on the curved line *mm*, and an impression on the line *mm* made with a needle point, the position of the valve rod, and

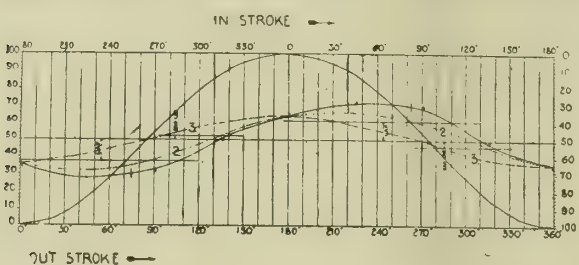


Fig. 5.

therefore of the valve for the given position is obtained. By repeating this process for each point E, the complete movement of the valve for one revolution of the crankshaft is found. This valve travel must now be transferred to Fig. 5, and thus is obtained the curve 1. Two more curves 2 and 3 are also shown in Fig. 5. Curve 3 is obtained with the reversing lever in the neutral notch or mid gear, while curve 2 is for an intermediate notch.

Comparison of Stephenson and Walschaert Curves.

The main feature which distinguishes these curves from the curves 1, 2, and 3 in Fig. 3 is the constant lead for all notches, in contradistinction to the diminishing lead which is characteristic of the Stephenson gear with crossed rods when notching up.

City Electric Light Co., Brisbane. The report of the directors of the City Electric Light Co., Brisbane, for the year ended January 31st shows that after making additions to the franchise and purchase sinking fund, and renewal, replacement, and contingencies account, there remains a credit balance of £42,519, which, with the balance brought forward from last year, makes a sum of £42,933. Out of the profits the directors paid an interim dividend, with dividend duty in September, amounting to £20,115; a further dividend of 3 per cent on preference shares and 5 per cent on the ordinary shares was paid last month, leaving a balance of £431. No statement is given regarding the revenue of the company for the period, and no statistics are furnished as to the cost of generation, distribution, etc.

The chief feature of the turret lathe tools described in a new catalogue sent us by Messrs. Alfred Herbert Ltd., Coventry, is their adaptability to other makes of machines. The catalogue, which is well illustrated, is comprehensive, and includes tool holders, centring, facing, and drilling tools, boring bar, boring cutter micrometers, drill chucks, dieheads, taps, etc. It is claimed that they meet adequately any demands likely to be made on turret lathes. There is a convenient diagram and table of dimensions, and also a chuck capacity chart which should prove useful. The firm are able to supply these tools from stock, as they are producing them surplus to the requirement of their machine output.

SHEET METAL MACHINES.

Messrs. Regent Shears Ltd. have placed on the market several improvements for sheet metal machines. Figs. 1 and 2 represent respectively their inclinable power press and 7 ft. by $\frac{1}{4}$ in. power shears. The power presses have a simple tilting device, and they can be equipped with any type of automatic feed for quantity production. The power shears are made in several sizes for cutting steel plate cold.

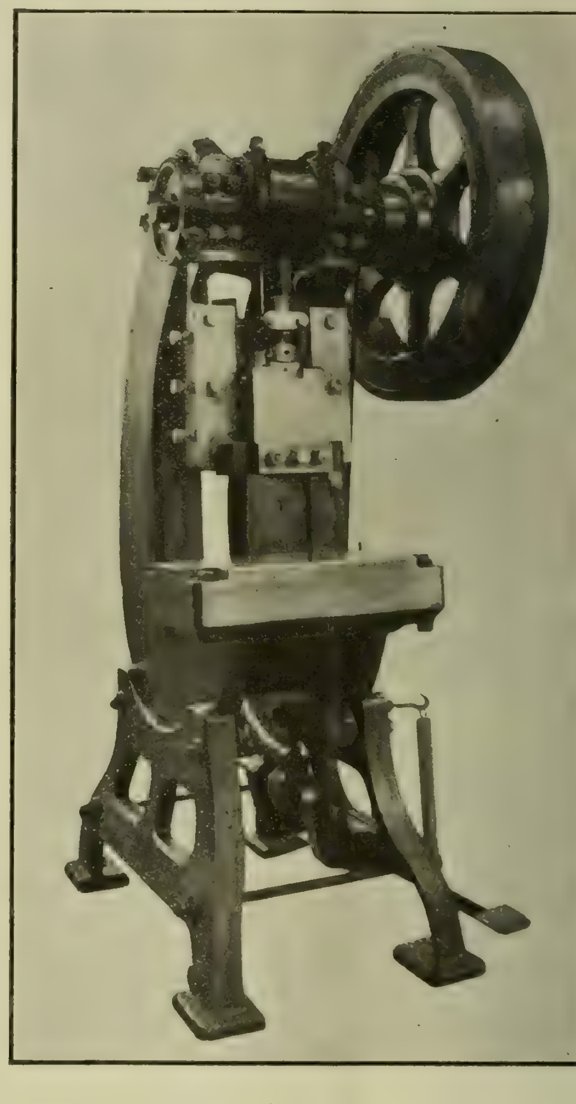


Fig. 1.

The patent micrometer adjustment, shown at Fig. 3, is for the purpose of raising the bottom blade of a plate shearing machine, to take up the difference in wear occasioned by the grinding operation. Resting on the ledge formed in the body of the machine is a male adjusting piece B, the top edge of which forms a series of taper bearing surfaces. Between this and the bottom shear blade is a female distance piece A, with its bottom edge similarly formed, and in contact with the male member. By drawing the bottom bar along, by means of the micrometer screw arrangement C, at the end, the shear blade is elevated or depressed as desired, to give the requisite adjustment to the

cutting edge, an operation which is claimed to be simple and accurate, the blade being adjusted in perfect parallel, and to any amount within ·001 by turning the knurled nut.

The object of the Regent automatic mechanical brake (Fig. 4) for presses and shears is to reduce the power necessary for driving the machines, when the braking action is not necessary. The functions of a brake when fitted to any machine which is actuated by a positive clutch are, primarily, to prevent the ram or beam from dropping or beating

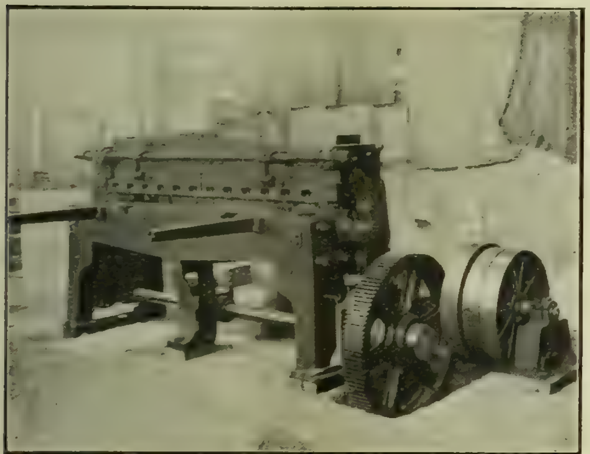


Fig. 2.

the flywheel, and to prevent the crank from rebounding when the clutch is knocked off.

It is claimed for the new brake that it does this effectively. The brake drum A is keyed in the usual manner to the crankshaft B. A cam piece C is pivoted on the stud K in A, and is provided with slotted holes for two locking studs. A roller D is carried on the lever E, which rocks on the stud J carried on the frame of the machine. A brake strap F is anchored at the short end of the lever E, and

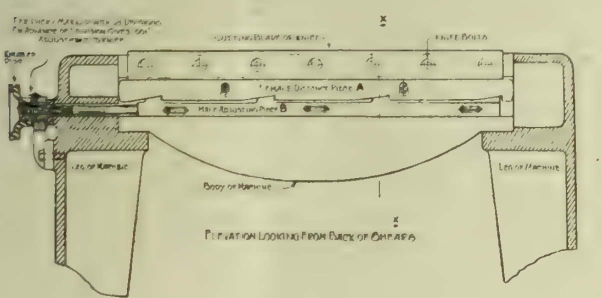


Fig. 3.

going round the drum A is connected to the long arm of E by an adjusting member G, which is provided with a spring H for regulating the braking effort.

It will be seen from the drawing that the position of the cam piece C may be varied to suit any condition of working, as enumerated above, by moving into positions X or Y. As shown by full lines, cam C is in position so that brake is "on" during the whole of the "up" stroke. When in position X brake is only "on" when clutch is knocked off, and when the ram is at the top of the stroke. When in position Y, brake is "on" during down stroke and when clutch knocks off.

It is simply constructed, and the tendency of the crank to rebound is resisted effectively. From the sketch it will be seen that when the brake drum tends to revolve in a direction opposite to its working direction the long arm of the lever E moves more than the shorter arm, making the braking effect

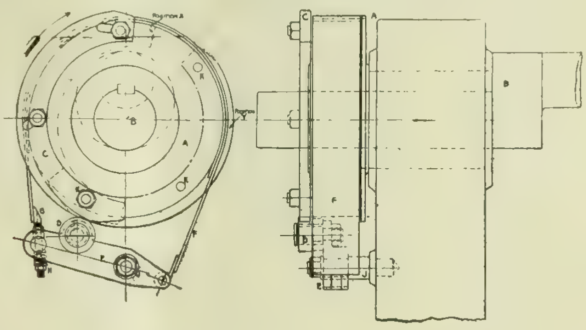


Fig 4.

differential, and the crank will not rebound unless the brake band is broken.

Fig. 5 illustrates the firm's improved safety clutch, Diagram A showing the disengaged and B the engaged position. The rod C is coupled to the foot lever, and when in the raised and free running position latches over a sliding stop D. As the crankshaft G revolves, the stop D forms an effective butt for a half-moon shape key arm E, thus withdrawing the crankshaft from engagement with the flywheel. Depression of the foot lever draws the link D down, thus allowing the key E which is spring-

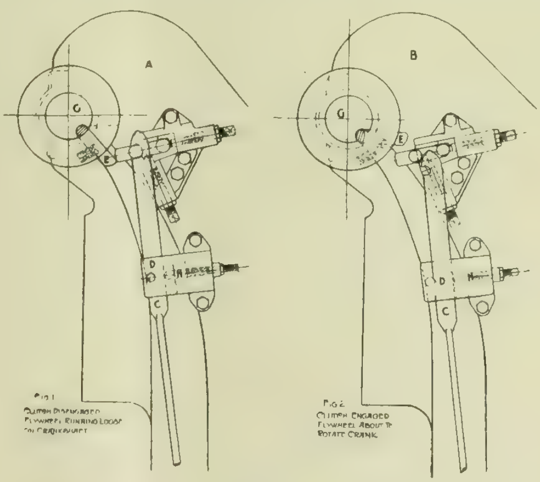


Fig. 5.

loaded to engage with the flywheel and a stroke of the ram is made. The roller H draws off the rod C from the link D, and thus the link D, returning to its normal position, enables only one stroke to be made for each depression of the treadle. The withdrawal of the pin H, however, enables the press to operate continuously so long as the foot lever is depressed, this feature being essential where a press is fitted with automatic feeds, such as roll feeds, dial feeds, lateral feeds, etc.

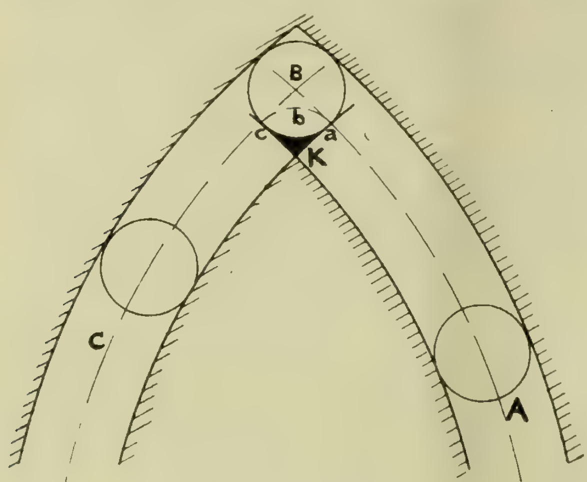
CAMS.

By W. E. Bennison, A.M.I.M.E.

(*Continued from page 378.*)

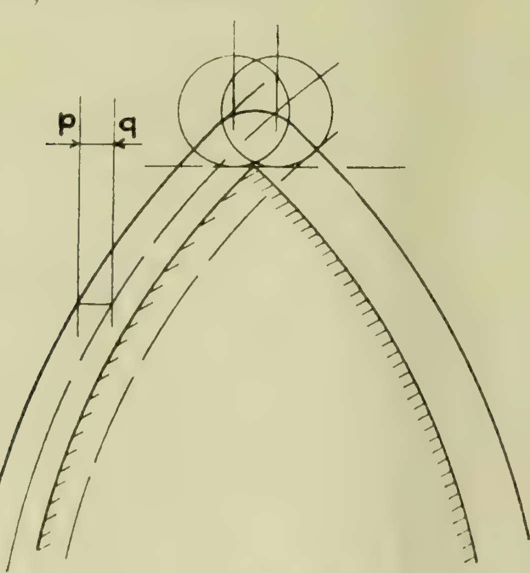
Interference.

Interference occurs when two cam forms cross each other. It is best shown by an example. In Fig. 64 the roller is moving along the path ABC, the point B being a sharp turn. If the follower were a point it would be able to follow the required path, but



Cams.—Fig. 64.

owing to the size of the roller the actual cam form is some distance away from the centre. Actually the two arms of the cam cross each other at the point K, and beyond that point mutually destroy each other. The roller would, in fact, roll round the point K, and its centre would follow the arc *a b c*,



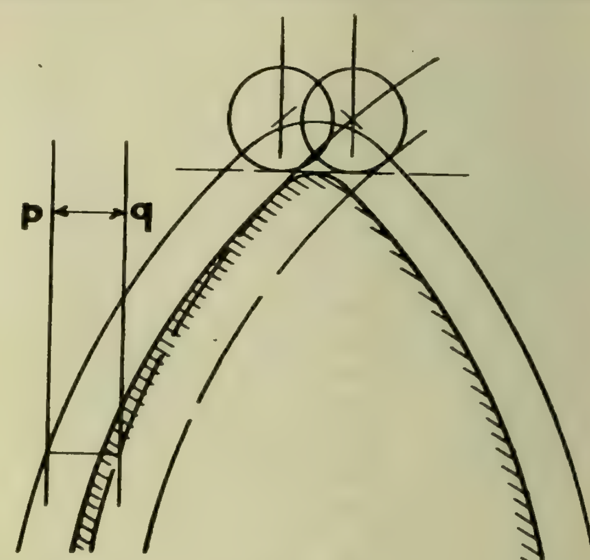
Cams.—Fig. 65.

thus losing motion by an amount *b*B. The black portion shows the amount of interference.

There is no way out of the difficulty. The cam must be "doctored." Four ways of "doctoring" are open: (1) the stroke must be reduced; (2) the slope of one or both curves must be altered; (3) the time of the forward stroke must be advanced; or (4) the time of the return stroke must be delayed.

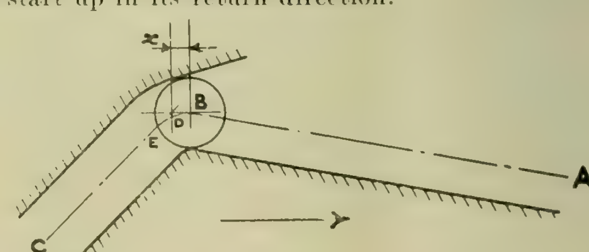
Fig. 65 shows the method of delaying the return stroke. If a joining curve is used to round off the point the delay will be still greater, as shown in Fig. 66. The horizontal distance P*q* between the old and new paths will give the amount of delay in each case.

Fig. 67 shows another case of interference, and Fig. 68 how the cam was doctored to overcome the interference. It was intended that the roller should



Cams.—Fig. 66.

take the path A, B, C, but owing to interference at the point K the centre would have moved along the arc *a b c*, consequently shortening the stroke, which could not be allowed. A small arc was inserted at K, and in rolling round this curve the centre of the roller travelled the much larger arc B D E. The new path C E was drawn tangent to this arc. The amount of loss is denoted by *x*. The small loss in time, however, was more than compensated for by the ease with which the new curve caused the follower to start up in its return direction.



Cams —Fig. 60.

It may be mentioned here, what no doubt has been observed, that it takes time for a roller to roll round a point. The centre of the roller always describes an arc round the point. This fact should be taken account of when laying out the cam, and provision made in the early stages for rounding off the peaks and valleys.

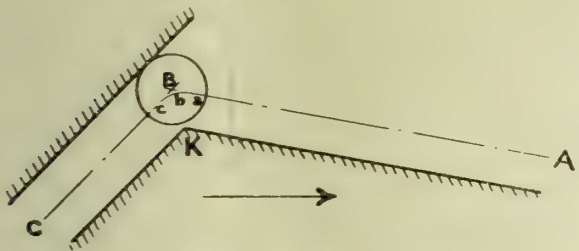
Cam Details.

Proportions of Cam Parts.

Some of these have already been mentioned.

The cam must have a good grip of the shaft, and the boss must be heavy enough to give this. The boss diameter will follow ordinary practice for pieces keyed to shafts. For length of boss $1\frac{1}{2}$ diameters is good average practice; helical cams being cylindrical usually have longer bosses than are required for strength. When the boss is long the hole should be cored out in the middle, leaving a bearing portion at each end. Large diameter cams should be very securely keyed on, and two keys may be required if the load is heavy or if shocks are present.

The thickness of a spiral cam depends upon the

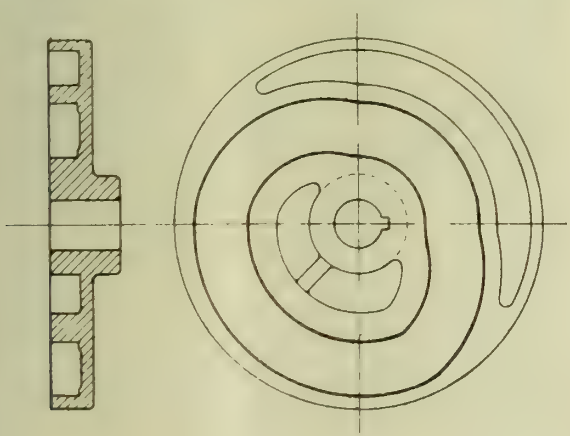


CAMS.—FIG. 68.

width of rollers. The plate or web should be thick enough to withstand any centrifugal forces and also the stress set up by the pressure of the follower. This applies also to the rim of a helical cam.

In double acting cams the sproud or outside wall of metal should be thick enough to withstand the pressure of the follower even after considerable wear has taken place.

When cams are heavy, large in diameter, or of high velocity, they should be balanced; this can be done by massing or relieving the metal in the



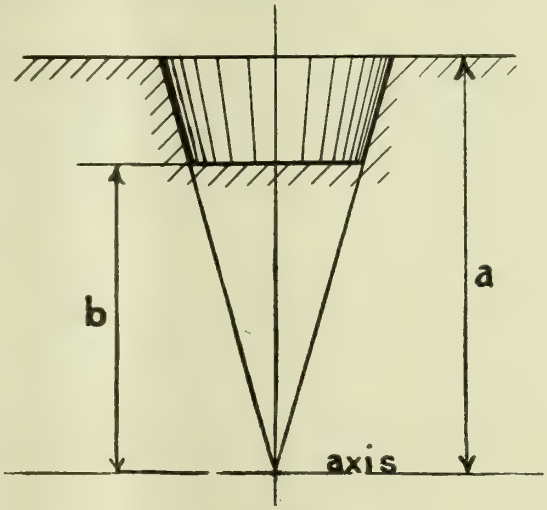
CAMS.—FIG. 69.

requisite places. It is also helpful to rough-turn the sides and rim. Fig. 69 shows how the metal can be arranged for a spiral cam. The cam is made circular in shape, and the solid lumps of metal are relieved by casting recesses of the same depth as the roller way. These recesses also serve to minimise the cooling stresses by equalising the thickness of the metal.

Cam Rollers.

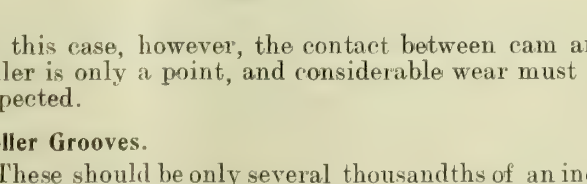
No rule can be given for the sizes of these. The diameter should be as small as is consistent with strength and durability; it will be to some extent determined by the diameter of the roller pin, which must be large enough to withstand the bending and shearing stresses.

The width of the roller depends upon the probable amount of wear; it rarely exceeds one diameter, and is usually greater than $\frac{1}{4}$ diameter. It is kept as narrow as possible in order to reduce the overhang of the pin. It must be borne in mind that the roller pin is usually a cantilever. The roller for a helical cam should be made conical. (See Fig. 70.) The shape will be a truncated cone whose apex is on



CAMS. – FIG. 70.

the axis of the cam. It is easily seen that the top of the groove (radius a) is travelling at a greater velocity than the bottom of the groove (radius b), and therefore if the roller were parallel the top would tend to revolve faster than the bottom, and thus wear flats. If made as shown in the figure all parts revolve at the same speed. If, however, the cam were of large diameter and the roller narrow this difference in velocity would be so slight as to be negligible. Sometimes, in order to save expense, the groove is made with parallel sides and the roller barrel shaped.



CAMS. – FIG. 71.

In this case, however, the contact between cam and roller is only a point, and considerable wear must be expected.

Roller Grooves.

These should be only several thousandths of an inch larger than the roller diameter. The roller should run freely round every part, but without any play. The depth of the groove is made just equal to the width of the roller. The bottom of the groove is usually relieved, as shown in Fig. 71, so that the roller only bears on two narrow strips.

Materials of Cams.

Cast iron is the usual metal for cams, especially if they are of any size. If the metal is hard and close grained it will stand a great amount of wear and run well with both cast iron and hardened steel rollers.

Small cams are frequently made of mild steel and case-hardened on the profile. This is so in the case of the Brown and Sharp Automatic, whose cams are small and narrow, but yet stand an extraordinary amount of work.

Aeroplane cams are usually made of hardened steel, in some caes the cam and shaft being in one solid piece.

When cams are built up the drum or disc will usually be of cast iron, and the cam pieces may be cast iron, malleable iron, steel casting, or mild steel case-hardened.

Both the rollers and pins should be hard. It is advisable to make them of mild steel and case-harden, afterwards grinding. For large rollers cast iron is usually adopted.

Durability and good wearing surfaces are the things to be aimed at in selecting materials for cam construction.

(To be continued.)

THE CHEMICAL SIDE OF LUBRICATION.

SOME MINUTE, DAMAGING PHASES.

Written and Illustrated by James Scott.

I am afraid there are many engineers who still harbour the idea that scientists are prone to lay too much stress on the necessity for being extremely careful in the selection of lubricants. But this is not the case, as workers would discover if they probed deeply into the matters relating to this important, yet too little understood, subject. In a general way, actual practice follows lines which suggest that those in charge of machinery and engines realise the broad principles underlying the nature and operation of lubricants, but there is insufficient attention in several quarters to what may be termed its minuter aspects. Highly trained engineers know and appreciate the facts to the utmost extent; it is in connection with the ordinary class of men—and I do not intend any slight by the reference—that it is considered quite satisfactory if all the metallic parts of engines, etc., run with apparent smoothness, and prevent seizing and consequent groaning, squeaking, rattling, jolting, and the other faults which signify bad results of lubrication.

There is, however, a chemical phase of the matter besides a mechanical one, and surprising as it may appear to uninitiated men, some of the easiest-going contrivances wear out far more rapidly than they should do, simply because the greases and oils which have been used on them have insidiously corroded the metals.

I have heard of cases in which the metals have been blamed when the lubricant has been the real cause of the damage.

This article is intended to emphasise the value of proprietary productions over those which have been chosen in a merely haphazard manner. The manufacturer—presuming he is one of proper repute—usually offers goods prepared from formulæ which have been adequately tested, so that reliance may be confidently placed on their merits.

On the other hand, a lubricant of unknown composition, without any sponsor for its recommendation, may be absolutely deleterious, although some time might elapse before its faultiness became manifested, and even then it is possible for the true origin of any trouble which developed to remain wholly unsuspected.

Such circumspection as I am hinting at is not, of course, called for in the commoner, less complicated, kinds of machinery, etc., but it is very essential indeed in instances where considerable risks to life and property may be involved by mishaps. Moving parts which are gauged up to thousandths and less of an inch contact, for example, entail a great deal of far-reaching dislocation if they wear undetected to a very slight degree. Yet some lubricants, nominally very excellent ones, are capable of dissolving the metals so steadily that they continue to disclose level surfaces, yet are thinned down far

Fig. 1.—One twenty-fourth inch of a yellowish deposit of aluminium oleate formed in lubricating oil; magnified.

more than they should be, and are invested with a netted system of cracks finer than hairs. Repeated examination fails to show anything of a serious character in these metals, yet continual vibration may result in forcing the cleanly split portions to yield definite, and probably disastrous, fractures, which then become evident.

When anything of this kind occurs, or shows signs of appearing, it would be wise to have the lubricant tested by a thoroughly competent oil analyst, and not be content with having only the metals dealt with in this way. This should be regarded as good advice.

Mineral oils, *e.g.*, petroleum products, do not contain or form any acid. (Some sulphuric acid may be, but rarely is, found in them, through insufficient refining processes, in which this acid is employed, it being subsequently neutralised by caustic soda). Neither do mineral oils contain, or attract, oxygen, whereas a large number of vegetable and animal oils either have free acid—termed oleic acid—or attract oxygen to themselves and form this acid under certain conditions.

Mineral oils are often dark, with a greenish or other coloured fluorescence or "bloom," but some of them are "debloomed," and therefore clear in this respect, and are then not unlike organic oils to the sight and feel.

It is a widespread practice to mix mineral oils and organic oils together, so that the series of available lubricants becomes very complex. In correct quantities one kind checks the disadvantages of the other. Mineral oils do not go rancid nor get "gummy," so that in a mixture these traits of organic oils are reduced.

The majority of organic lubricants are called glycerides, because they consist of compounds of glycerine (synoynm, glycerol) and a fatty acid, such as palmitic, stearic, or oleic. The terms palmitin, stearin, and olein are adopted to define the individual compounds of glycerine with the separate acids named, but in most oils and fats the "ins" are mixed together in various proportions. Palmitic and stearic acids, when isolated from their glycerine are solid, glistening, white waxes; oleic acid is an oil when thus extracted. It is possible for some percentage of either or all of them to get freed during use, although they still remain fluidised in the parent substance or whole lubricant.

Other acids found in conjunction with various constituents in lubricants are butyric, lauric, valeric, arachidic, cerotic, erucic, linoleic, and rapic.

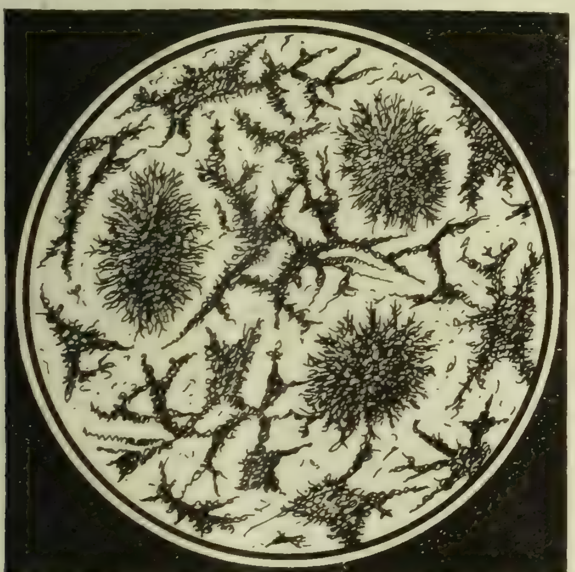


FIG. 2.—One twenty-fourth inch of a greenish residue of copper oleate formed in lubricating oil; magnified.

Additional ones, with better-known names, such as acetic series, are evolved in oils and fats. They are so well compounded that it is only after the decomposition of the lubricant that they are obtainable.

Oleic acid—which practically means oily acid—oleum is the scientific name for oil—is probably the worst offender in lubricants, and will in time bring about amazing and mysterious changes in the structure of metals. It is a component of most of the customary run of lubricants, such as tallow, lard, palm oil, rape oil, cotton seed oil, whale oil—but not sperm oil.

Various quantities of these fats and oils are mixed together in a large number of popular lubricants. The harder greases contain palmitic acid and stearic acid (combined with glycerine) than they do oleic acid, which being fluid—except in frosty weather—does not so readily unite with glycerine as the denser acids do.

Above a mere trifle of oleic acid in a free state in a lubricant is capable of proving very obnoxious.

In analysis it is a regular proceeding to regard the acid factor as oleic, even when it is reasonable to believe that palmitic and stearic, or other more obscure acids, are dissolved in it. When an oil is left standing some time, more especially during winter, a deposit often settles in it. This is generally spoken

FIG. 3.—One twenty-fourth inch of a reddish residue of iron oleate formed in lubricating oil; magnified.

of as stearin; but should the oil be working, and therefore all fluid, any acidity in it is spoken of as oleic acid, even though it may be derived from decomposed stearin, palmitin, or another source.

There really is no other means of expressing one's conclusions. The hard and fast terms oleic acid, stearic acid, and palmitic acid are not sufficiently discriminating to describe mixtures of these acids in intermediate conditions, although they are suitable for use with the separated, distinct acids.

Oleic acid cannot do much harm to metals in the absence of moisture and oxygen, which, however, are ever present in the atmosphere, and are generated from steam, etc., and frequently from the lubricants themselves. They are, as it were, everywhere, even when not obvious. Oleic acid can dissolve elemental metals, or the individual constituents of alloys—for instance, the copper from brasses and bronzes, and the lead from white metals. The compounds of oleic acid and metals are known as oleates.

Lubricants, and therefore the acids in them, which could not exert any chemical action in the cold state, obtain the power to do so when the metal becomes hot through working. It is not very widely known that lubricants get hotter than the moving metals between which they flow. It is for this reason that they sometimes ignite and explode when overheated, owing to their sudden decomposition into inflammable gases. It is a similar, but less fierce, splitting up which may produce free oleic acid in an oil which

had hitherto held it only in a combined, innocuous condition.

I have been very careful in obtaining from engineering sources, and by direct experiments, metallic residues which have been dissolved out by the oleic acid of derogatory lubricants. It does not follow that such oils are manifestly inferior, but they would not have been sold by experts in the oil industry.

I have selected for illustration the oily solutions of aluminium, copper, iron, and lead, which would respectively be called, in technical language, the oleates of aluminium, copper, iron, and lead. I viewed layers of these substances, about ⅛ in. thick, in shallow glass jars, because the films of them on glass slides were too thin to be of much account. Oleic acid is brownish in commercial oils, although when absolutely pure it is white.

The used lubricant which contained oleate of aluminium was yellowish; that of copper, greenish; that of iron, reddish; that of lead, dark brownish.

In these oils were minute fatty bubbles of various shapes, odd granules, specks, and indefinite flakes. I depict what I regard as the most characteristic features. It must be understood that the oils were not crammed with these objects. But they would form a deposit in bottles and cans if the oils were placed therein and left undisturbed for awhile. They were present in fair abundance, and denoted combinations of the modified oleic acid with the dissolved metal. Other forms were discernible in addition.

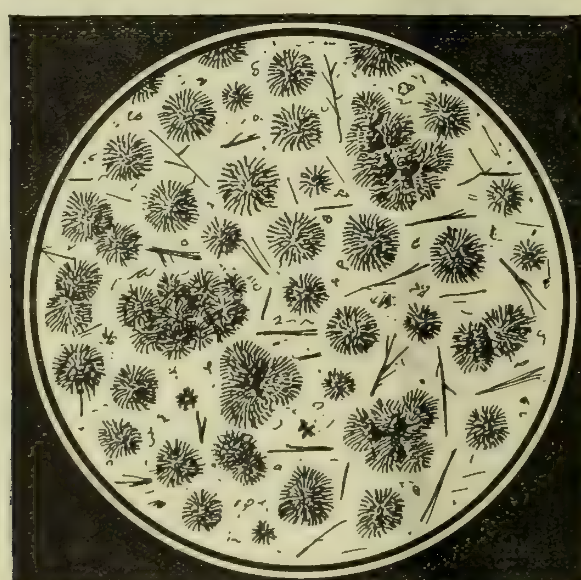


FIG. 4.—One twenty-fourth inch of a brownish residue of lead oleate formed in lubricating oil; magnified.

In the case of aluminium, a kind of nucleated, granular network, as shown in Fig. 1, became evident. In that of copper, flocculent, tufted ovals of the kind shown in Fig. 2, were conspicuous, intermingled with streamers of the same substance.

In that of iron, multitudes of dark specks were prominent, and these, by clustering together into fatty globules and sticking out from them, produced the figures shown in Fig. 3. When the globules melt, the specks get loosened.

In that of lead, rosetted balls and needle-shaped crystals were discernible, as shown in Fig. 4. The former are bunches of the latter.

In all these examples fluid metallic oleate remained coloured in the manner already explained. Whenever I examined them I could see minute changes going on inside the particles and globules, etc.

These habits help gumming and soaping, and, therefore, clogging of the lubricants to form.

The oleates are more dangerous than they otherwise would be, because repeated reactions in a heated state cause their combined metals to separate in an oxidised state as grit, leaving the oleic acid free to continue the corrosion by the formation of new oleates. There is really no end to this cycle, the oleic acid serving as a kind of catalytic agent enabling perpetual damage to accrue.

DESIGN AND APPLICATIONS OF "HIGH-SPEED GEARING."

By M. CORONEL.

(*Continued from page 374.*)

DETAILS OF DOUBLE REDUCTION MARINE GEARING.

These are usually of two different kinds, viz., the double reduction gear built in one casing, as shown in Fig. 23, and those built up of two or more single reducing gears of the type, as shown in Fig. 18, in conjunction with single reduction gears of the single pinion type, giving an arrangement as used in cargo vessels of high speed, known as "Class N" type (see Figs. 25 and 26, also photo plate 2). The efficiency of these gears is very high, and as much as 98 to 99 per cent. As will be seen from Table VI., the pitches of these gears for the S.H.P. transmitted is very small, and nobody a few years ago would have thought of transmitting, say, 500 B.H.P. through a ·2 in. thickness of tooth; but the fact that four or five teeth mesh wholly or partly at one and the same time, and therefore distribute the load evenly, largely accounts for this fact; also,

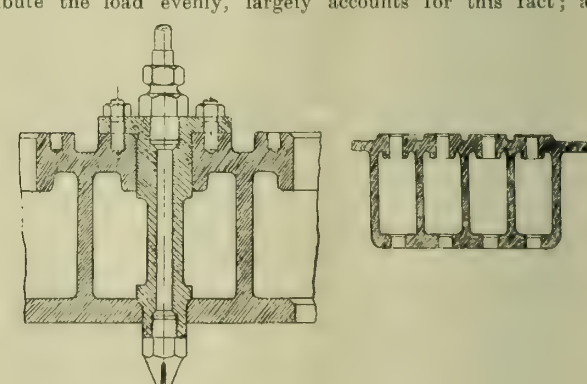


FIG 24.

due to the employment of double helical teeth, the grip on each tooth is more gradual and smoother. The advantage, of course, of the smaller pitches is the smoother running. The normal pitch, viz., the pitch measured at right angles to the teeth, is made as small as ·583 in., and is largely used in this country with about ·4 in. for small pinions, or where extreme silence is of great importance. About 30 mils. clearance between the teeth has been found very suitable for a free passage for the oil. In the U.S.A. large pitches are being used of ·9 in. or even more, but English practice does not appear to go usually beyond ⅞ in. circumference normal pitch. The minimum number of teeth for pinions is about 19 with normal tooth form, but not to go beyond 22 to 25 is more preferable.

The gear, as shown in Figs. 25 and 26, also on Plate 2, is really a combined installation of three single gears. The chief consideration being in this design is the rapid production.

The splitting up of the arrangement in three distinct parts made it possible to keep the weight of any part to a minimum for easy transport and handling. Ships equipped with gears of this design are now at sea running with very satisfactory results.

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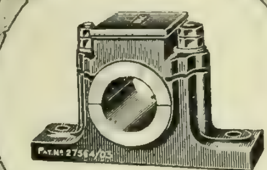

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Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 3 12	0 15 2 24	1 3 2 8	1 11 1 20	1 19 1 4	2 7 0 16	2 15 0 0	3 2 3 12	3 10 2 24	0
1	0 3 4	8 2 16	0 16 2 0	1 4 1 12	1 12 0 24	2 0 0 8	2 7 3 20	2 15 3 4	3 3 2 16	3 11 2 0	1
2	1 2 8	9 1 20	0 17 1 4	1 5 0 16	1 13 0 0	2 0 3 12	2 8 2 24	2 16 2 8	3 4 1 20	3 12 1 4	2
3	2 1 12	10 0 24	0 18 0 8	1 5 3 20	1 13 3 4	2 1 2 16	2 9 2 0	2 17 1 12	3 5 0 24	3 13 0 8	3
4	3 0 16	11 0 0	0 18 3 12	1 6 2 24	1 14 2 8	2 2 1 20	2 10 1 4	2 18 0 16	3 6 0 0	3 13 3 12	4
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7	5 2 0	13 1 12	1 1 0 24	1 9 0 8	1 16 3 20	2 4 3 4	2 12 2 16	3 0 2 0	3 8 1 12	3 16 0 24	7
8	6 1 4	14 0 16	1 2 0 0	1 9 3 12	1 17 2 24	2 5 2 8	2 13 1 20	3 1 1 4	3 9 0 16	3 17 0 0	8
9	7 0 8	14 3 20	1 2 3 4	1 10 2 16	1 18 2 0	2 6 1 12	2 14 0 24	3 2 0 8	3 9 3 20	3 17 3 4	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·34	14·68	22·02	2 1·36	1 8·7	1 16·04	1 23·38	2 2·72	2 10·06	2 17·4	2 24·74	3 4	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 88 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	Ft
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10	0 7 3 12	4 6 1 20	8 5 0 0	12 3 2 8	16 2 0 16	20 0 2 24	23 19 1 4	27 17 3 12	31 16 1 20	35 15 0 0	10
20	0 15 2 24	4 14 1 4	8 12 3 12	12 11 1 20	16 10 0 0	20 8 2 8	24 7 0 16	28 5 2 24	32 4 1 4	36 2 3 12	20
30	1 3 2 8	5 2 0 16	9 0 2 24	12 19 1 4	16 17 3 12	20 16 1 20	24 15 0 0	28 13 2 8	32 12 0 16	36 10 2 24	30
40	1 11 1 20	5 10 0 0	9 8 2 8	13 7 0 16	17 5 2 24	21 4 1 4	25 2 3 12	29 1 1 20	33 0 0 0	36 18 2 8	40
50	1 19 1 4	5 17 3 12	9 16 1 20	13 15 0 0	17 13 2 8	21 12 0 16	25 10 2 24	29 9 1 4	33 7 3 12	37 6 1 20	50
60	2 7 0 16	6 5 2 24	10 4 1 4	14 2 3 12	18 1 1 20	22 0 0 0	25 18 2 8	29 17 0 16	33 15 2 24	37 14 1 4	60
70	2 15 0 0	6 13 2 8	10 12 0 16	14 10 2 24	18 9 1 4	22 7 3 12	26 6 1 20	30 5 0 0	34 3 2 8	38 2 0 16	70
80	3 2 3 12	7 1 1 20	11 0 0 0	14 18 2 8	18 17 0 16	22 15 2 24	26 14 1 4	30 12 3 12	34 11 1 20	38 10 0 0	80
90	3 10 2 24	7 9 1 4	11 7 3 12	15 6 1 20	19 5 0 0	23 3 2 8	27 2 0 16	31 0 2 24	34 19 1 4	38 17 3 12	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Weight.
	39 5 2 24	78 11 1 20	117 17 0 16	157 2 3 12	196 8 2 8	235 14 1 4	275 0 0 0	314 5 2 24	353 11 1 20	392 17 0 16	

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0	..	7 3 2	0 15 2 4	1 3 1 6	1 11 0 8	1 18 3 10	2 6 2 12	2 14 1 14	3 2 0 16	3 9 3 18	0
1	0 3 3	8 2 5	0 16 1 7	1 4 0 9	1 11 3 11	1 19 2 13	2 7 1 15	2 15 0 17	3 2 3 19	3 10 2 21	1
2	1 2 6	9 1 8	0 17 0 10	1 4 3 12	1 12 2 14	2 0 1 16	2 8 0 18	2 15 3 20	3 3 2 22	3 11 1 24	2
3	2 1 9	10 0 11	0 17 3 13	1 5 2 15	1 13 1 17	2 1 0 19	2 8 3 21	2 16 2 23	3 4 1 25	3 12 0 27	3
4	3 0 12	10 3 14	0 18 2 16	1 6 1 18	1 14 0 20	2 1 3 22	2 9 2 24	2 17 1 26	3 5 1 0	3 13 0 2	4
5	3 3 15	11 2 17	0 19 1 19	1 7 0 21	1 14 3 23	2 2 2 25	2 10 1 27	2 18 1 1	3 6 0 3	3 13 3 5	5
6	4 2 18	12 1 20	1 0 0 22	1 7 3 24	1 15 2 26	2 3 2 0	2 11 1 2	2 19 0 4	3 6 3 6	3 14 2 8	6
7	5 1 21	13 0 23	1 0 3 25	1 8 2 27	1 16 2 1	2 4 1 3	2 12 0 5	2 19 3 7	3 7 2 9	3 15 1 11	7
8	6 0 24	13 3 26	1 1 3 0	1 9 2 2	1 17 1 4	2 5 0 6	2 12 3 8	3 0 2 10	3 8 1 12	3 16 0 14	8
9	6 3 27	14 3 1	1 2 2 3	1 10 1 5	1 18 0 7	2 5 3 9	2 13 2 11	3 1 1 13	3 9 0 15	3 16 3 17	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·25	14·5	21·75	1 1	1 8·25	1 15·5	1 22·75	2 2	2 9·25	2 16·5	2 23·75	3 3	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 87 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 17 2 20	7 15 1 12	11 13 0 4	15 10 2 24	19 8 1 16	23 6 0 8	27 3 3 0	31 1 1 20	34 19 0 12	0
10	0 7 3 2	4 5 1 22	8 3 0 14	12 0 3 6	15 18 1 26	19 16 0 18	23 13 3 10	27 11 2 2	31 9 0 22	35 6 3 14	10
20	0 15 2 4	4 13 0 24	8 10 3 16	12 8 2 8	16 6 1 0	20 3 3 20	24 1 2 12	27 19 1 4	31 16 3 24	35 14 2 16	20
30	1 3 1 6	5 0 3 26	8 18 2 18	12 16 1 10	16 14 0 2	20 11 2 22	24 9 1 14	28 7 0 6	32 4 2 26	36 2 1 18	30
40	1 11 0 8	5 8 3 0	9 6 1 20	13 4 0 12	17 1 3 4	20 19 1 24	24 17 0 16	28 14 3 8	32 12 2 0	36 10 0 20	40
50	1 18 3 10	5 16 2 2	9 14 0 22	13 11 3 14	17 9 2 6	21 7 0 26	25 4 3 18	29 2 2 10	33 0 1 2	36 17 3 22	50
60	2 6 2 12	6 4 1 4	10 1 3 24	13 19 2 16	17 17 1 8	21 15 0 0	25 12 2 20	29 10 1 12	33 8 0 4	37 5 2 24	60
70	2 14 1 14	6 12 0 6	10 9 2 26	14 7 1 18	18 5 0 10	22 2 3 2	26 0 1 22	29 18 0 14	33 15 3 6	37 13 1 26	70
80	3 2 0 16	6 19 3 8	10 17 2 0	14 15 0 20	18 12 3 12	22 10 2 4	26 8 0 24	30 5 3 16	34 3 2 8	38 1 1 0	80
90	3 9 3 18	7 7 2 10	11 5 1 2	15 2 3 22	19 0 2 14	22 18 1 6	26 15 3 26	30 13 2 18	34 11 1 10	38 9 0 2	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	38 16 3 4	77 13 2 8	116 10 1 12	155 7 0 16	194 3 3 20	233 0 2 24	271 17 2 0	310 14 1 4	349 11 0 8	388 7 3 12	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

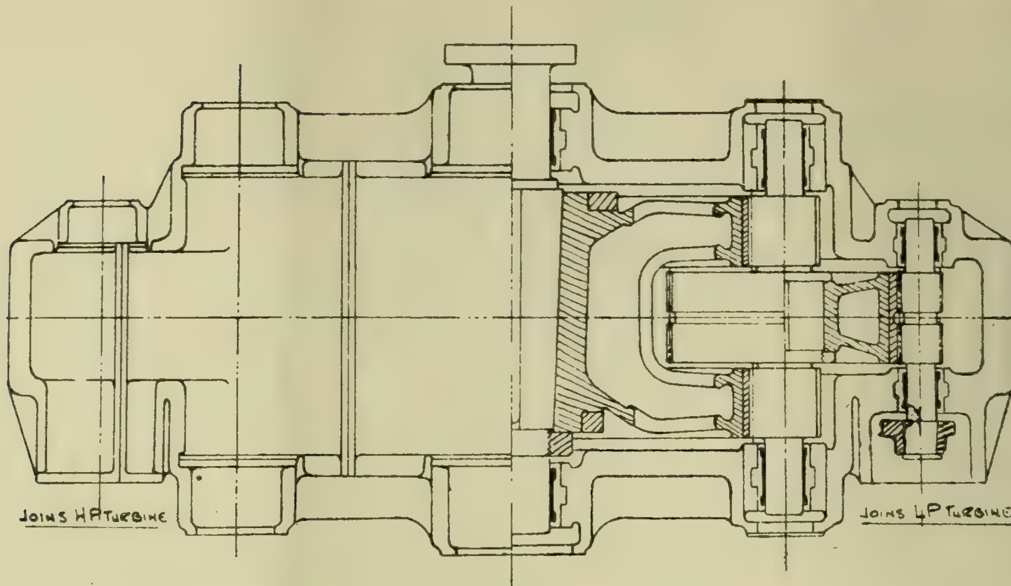

JOINS H.P. TURBINE
JOINS L.P. TURBINE

Fig. 23.

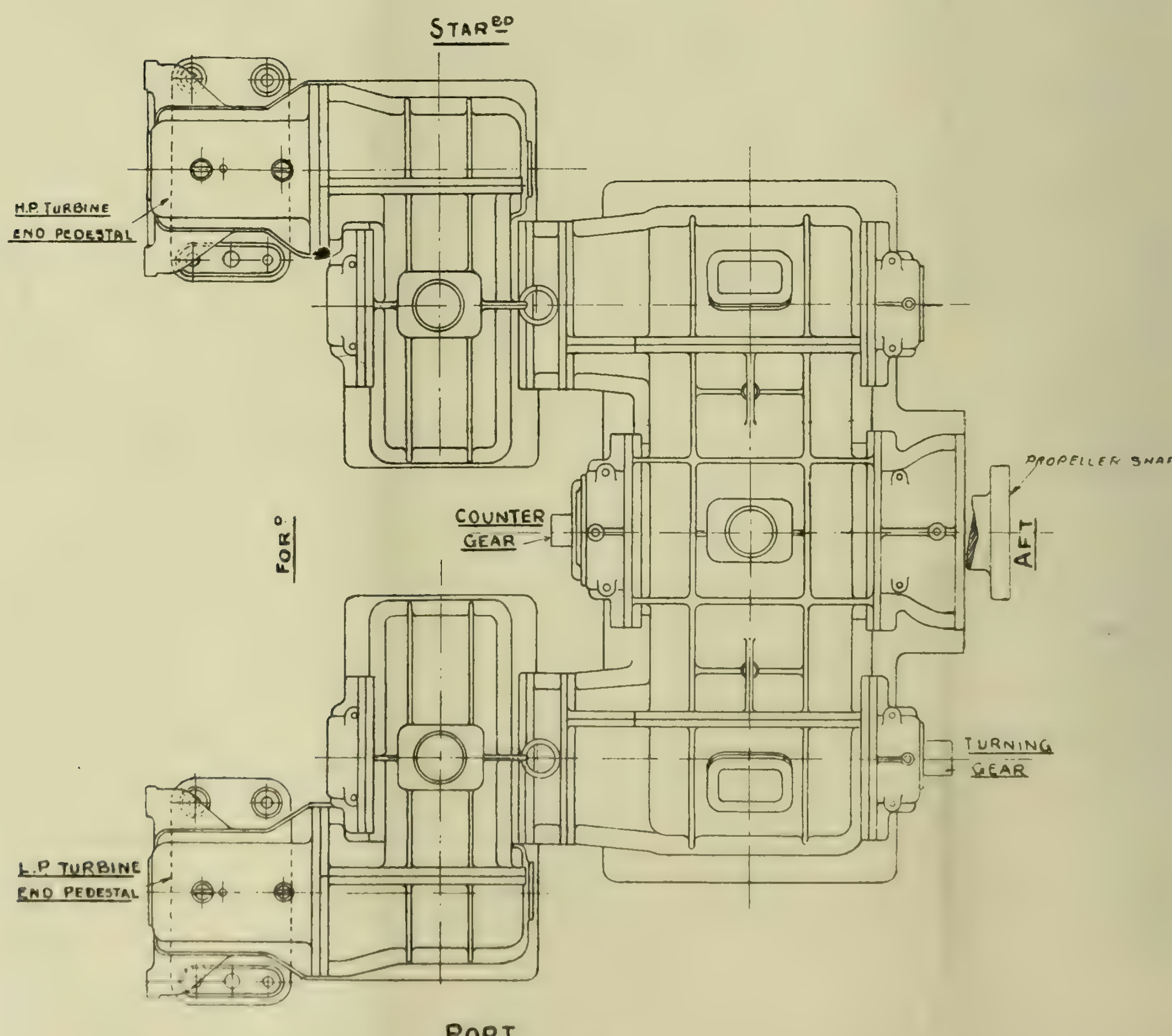

STARBD
H.P. TURBINE END PEDESTAL
COUNTER GEAR
FORD
AFT
TURNING GEAR
L.P. TURBINE END PEDESTAL
PORT

Fig. 25.

It does not appear probable, however, that future design will follow this arangement. The design shown in Fig. 23, although involving the use of larger castings and forgings, is more favoured and is adopted in latest practice.

Table VI. gives particulars of some cargo vessel reducing gears recently constructed. The figures may be useful for purposes of comparison, but too much importance should not be attached to them. It is impossible to lay down hard and fast rules for fixing the sizes of marine reducing gears. The propulsion system must be considered as a complete unit beginning in the boiler room and ending at the propeller.

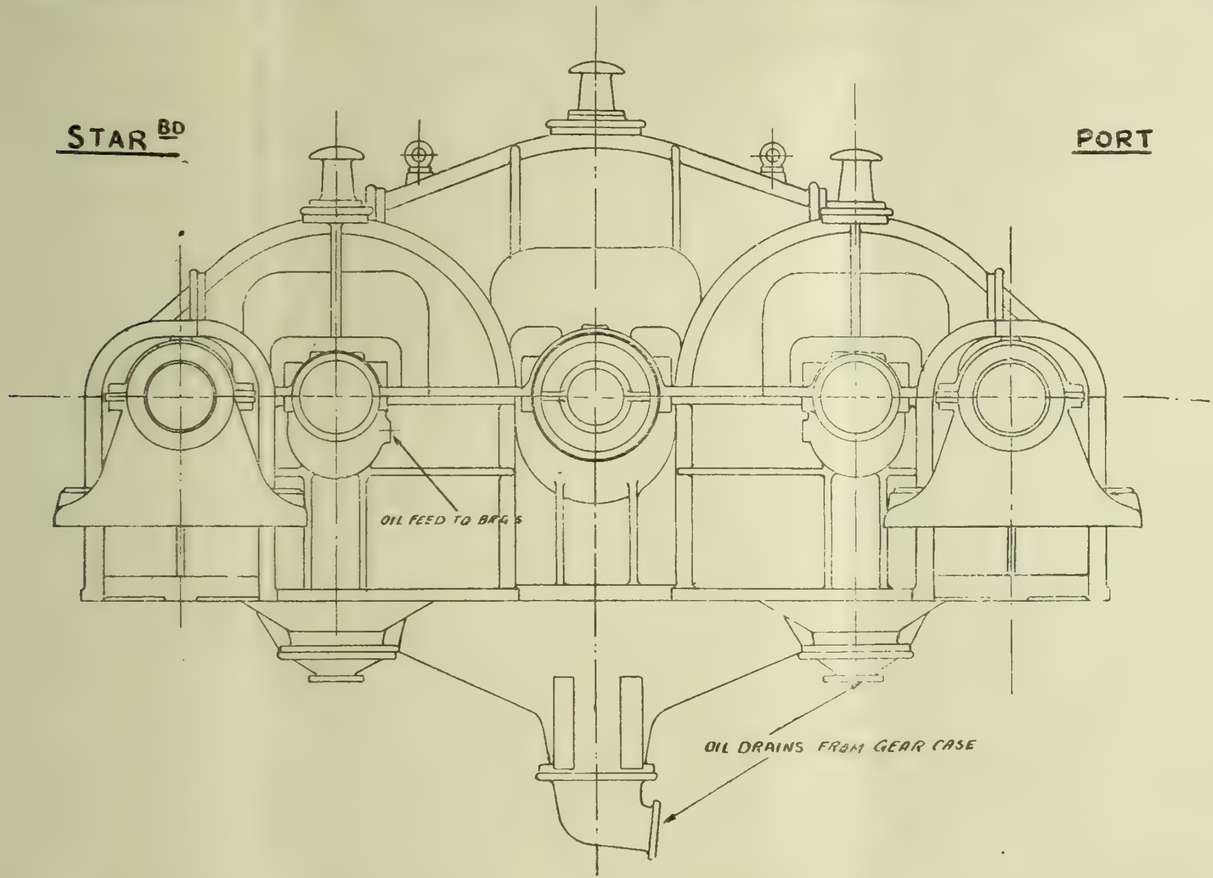


Fig. 26.

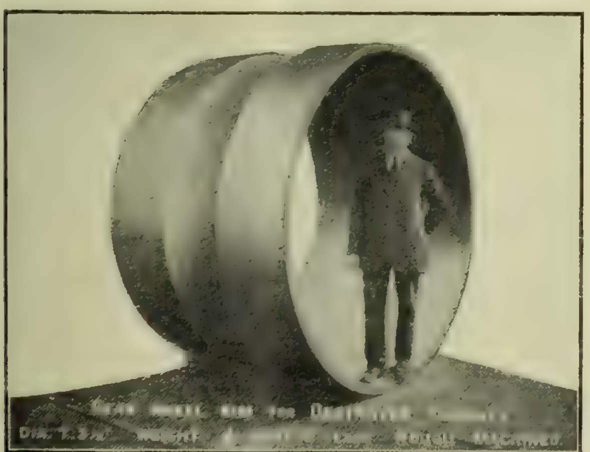


Fig. 27.

For those who are not marine engineers it may be advisable to briefly review the points influencing the gearing dimensions, assuming that the effective horse power, speed of ship, and the ship dimensions are given. The revolutions of the shaft are fixed to give a propeller suitable for the power speed and draught of ship. For example, in cargo ships ranging from 1,000 S.H.P. to 6,000 S.H.P. and a speed of 9 to 13 knots, the revolutions of the shaft vary from about 70 to 100 revolutions per minute. The turbine revolutions, to give economical blade speed, will vary from 4,500 for small powers to about 3,000 revolutions per minute for larger sets. This gives a gear ratio of 64 to 1 and 30 to 1 respectively. This ratio cannot be obtained in one reduction, because the main wheels are limited to a maximum of about

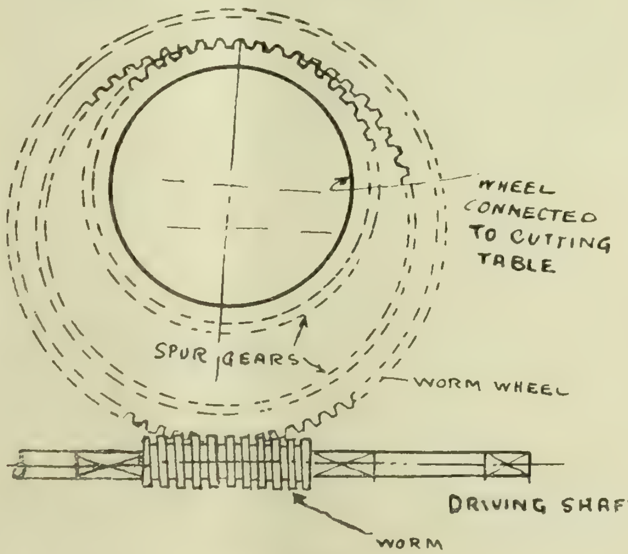


Fig. 28.

14 ft. diameter, the pinions to a minimum of about 5 in. diameter. This is the maximum capacity of most gear-cutting machines which generate the tooth with a hob. It is also very difficult to

make intricate castings either of steel or iron of this size, which weigh sometimes as much as 20 tons, the whole gear and case weighing as much as 30 tons, depending on the face width.

It is obvious, therefore, that this class of ship should be fitted exclusively with double reduction gears. For very fine high-speed ships single reduction gears are more often adopted. Some loss in economy is entailed, but where space and weight have to be cut down this is inevitable. Gearing ratios will vary for warships from 6 to 1 to 20 to 1 in merchant ships.

TABLE VI.—Double Marine Reduction Gears.

Turbines.	H.P. & L.P.	H.P.	L.P.
Turbine horse power	500 each.	1625	1625
Turbine revs.	3600	3284	2702
First Reduction Gear.			
Pinions :—			
P.C. diam., ins	4·58	6·18	7·28
No. teeth	36	32	38
Pitch teeth, ins	·4	·6	·6
Face width, ins	9	17·5	17·5
Wheel width, ins	10	19	19
Wheel :—			
P.C. diam., ins	35·8	49·8	51·6
No. teeth	281	261	265
Gear centres	20·75 in.	28 in.	28 in.
Bearings :—			
Pinion shaft	2 at 2·75 × 6·5″	2 at 4 25 × 10″	2 at 4·25 × 10″
Wheel ,,	2 at 4·5 × 5″	2 at 6·5 × 7″	2 at 6·5 × 7″
Tooth speed, circl. ft. per min	4320	5320	5150
Tooth press., per in. width	425	575	590
Torque, in.-lbs	8750	31200	37500
Bearing press., lbs. per sq. in	106	117	121
Surface speed, ft. per min	2600	3650	3000
Max. stress in shaft, lbs. per sq. in.	2150	2070	2500
Second Reduction Gear			
Propellor, S.H.P.	1000	3250	...
Propellor, revs	80	64	...
Two Pinions :—			
P.C. diam	9·42	13.65	...
No. teeth	37	41	...
Pitch teeth, ins.	·8	1·0	...
Face width, ins	20	36	...
Wheel width ins	21·5	38	...
Wheel :—			
P.C. diam., ins	54	82·2	...
No. teeth	212	258	...
Gear centres, ins	2 × 31·75	2 × 47·5	...
Bearings :—			
Pinion shafts	4 at 9 × 13″	4 at 8·5 × 22″	...
Wheel ,,	2 at 11 × 12″	2 at 15·5 × 14″	...
Tooth speed circl ft. per min.	1130	1380	...
Tooth press., per in width	390	820	...
Torque, in.-lbs	800,000	3,200,000	...
Bearing press., lbs. per sq. in.	29·5	68	...
Surface speed. ft. per min.	232	260	...
Max. stress in shaft, lbs. per sq. in	3060	4410	...
Ratio first reduction	7·8	8 15	7·0
Ratio second reduction	5·73	6·3	...
Total weight gear tons	21	32	...

LUBRICATION OF MARINE GEARS.

One of the most important considerations in marine gearing is the lubrication of the bearings and the gears, and every care should be taken to keep a continuous flow of oil to the bearings and the gear teeth in mesh. A complete forced lubrication system is fitted for the bearings entirely independent of the gearing. The system may be more or less standardised, but usually each design of gearing is specially catered for at the present. The author, however, is confident that some standard system will eventually be adopted throughout. The number, size, surface speed of the journals, together with the tooth speeds and the pressures on the gear teeth, determine the quantity of oil required to pass through the system in a given time. For the gearing about one gallon per minute for every 100 to 150 S.H.P. transmitted can be allowed. The quantity of oil for the bearings can approximately be computed by the heat absorbed by the oil film and by fixing a predetermined maximum temperature rise from the well-known mechanical heat equivalent formula :—

$$\text{Quantity of oil } Q = \frac{A\,p\,V \times 3600}{778 \times 9 \times \cdot 3 \times \delta t} \text{ in gallons per hour.}$$

Where A = area of oil film in square inches.
p = sheer force of the oil film in lbs. per sq. in.
V = speed of shaft surface in feet per second.
778 = is the mechanical heat equivalent in ft.-lbs.
9 = the weight of one gallon of oil in lbs.
$\cdot 3$ = the specific heat of the oil ; and
δt = the allowable temperature rise.

The only doubtful value is p, and has been ascertained by experiment for some cases. (See Brown Boveri's Review, 1917, for some values.)

A short description of the forced lubrication system as applied to ships may be of interest.

The gear case trough drains into a tank, which is either a separate unit or built into or forming part of the ship's floor. Vertical direct-acting pumps are fitted, each large enough to supply the system, the other acting as a stand-by. The working pump draws from the drain tank through a suitable strainer or filter, and discharges the warm oil through a surface type cooler. The oil runs outside, the water inside, the tubes. After passing the cooler, it passes through a check valve, and is then forced up into the gravity tanks. Two gravity tanks are provided working in parallel and placed high enough in the engine room to give sufficient pressure, usually 10 lb. to 15 lb., required to force the oil through the bearings and sprayers. An alarm gear operating a bell or thrill whistle calls the attention of the engineer if the pumps should not maintain the working level in the tanks. If the tanks are running flooded, the surplus oil is run back to the drain tank through an escape pipe. The supply pipe from the gravity tank branches off to the sprayers and bearings. The teeth in mesh are sprayed over the entire length of the working face by means of nozzles, details of which are shown in Fig. 24. The subject of bearing lubrication is rather in an experimental stage, and no definite figures can be given at the present, but several articles appearing recently in the technical press may be useful on this point. Marine turbine gears are further fitted with a turning gear consisting of a worm wheel keyed on pinion shaft in which gears a worm carried by a swivelling bracket. The worm spindle is turned by means of an extended ratchet handle from 6 ft. to 4 ft. long, or is mechanically operated. As soon as the turbine starts running, the turning action throws the worm out of gear, and can be locked in that position by a pin. A counter gear is also fixed usually on the slow-speed shaft on the opposite end from which the propeller shafts protrude (see Fig. 25).

(Concluded.)

TIDAL POWER.

So far no tidal power development of any appreciable size has been carried out, although the idea is an old one. The present high cost of fuel and water power development in general has, however, revived interest in the subject, and the commercial possibilty of such schemes is at the moment receiving serious consideration both in this country and in France. According to an article on the subject in the June 3rd issue of *Nature*, from which the following particulars are derived, the power which may be developed from a tidal basin of given area depends on the square of the tidal range, and since the cost per horse power of the necessary turbines and generating machinery increases rapidly as the working head is diminished, the cost per horse power of a tidal-power installation, other things being equal, will be smallest where the tidal range is greatest. It is for this reason that the western, and especially the south-western, coasts of Great Britain, and the western coast of France, are particularly well adapted for such developments, since the tidal ranges are greater than in any other part of the world, with the possible exceptions of the Bay of Fundy, Hudson's Bay, and Port Gallelos, in Patagonia.

In Great Britain the highest tides are found in the estuary of the Severn, the mean range of the spring tides at Chepstow being 42 ft., and of the neap tides 21 ft. In France the maximum range occurs at St. Malo, where it amounts to 42·5 ft. at spring tides, and about 18 ft. at neap tides. The tidal range in the Dee is 26 ft. at springs; and 12 ft. at neaps, while the mean range of spring tides around the coast of Great Britain is 16·4 ft., and of neap tides 8·6 ft. The article briefly outlines and compares

the five most promising schemes of development that have been suggested, and goes on to point out that the great difficulty in developing a tidal scheme as compared with an orthodox low head water-power scheme arises from the relatively great fluctuations in head. In the case of the Severn, for example, the working head at springs would be twice as great as at neaps, and the energy output per tide would be four times as great at springs as at neaps, while at St. Malo the output would be 5·5 times as great at springs as at neaps.

Not only is the installation subject to this cyclical fluctuation of head, but in any simple scheme the turbines also cease to operate for a more or less extended period on each tide; and this idle period will gradually work around the clock, and will, at regular intervals, be included in the normal industrial working day.

In any installation, then, designed for an ordinary industrial load, unless the output is cut down to that obtainable under the minimum head available at the worst period of a neap tide, in which case only a very small fraction of the total available energy is utilised and the cost of the necessary engineering works per horse power will, except in exceptionally favourable circumstances, be prohibitive, some form of storage system forms an essential feature of the scheme.

Various storage systems have been suggested. Electrical accumulators must be ruled out, if only on account of the cost, and the same applies to all systems making use of compressed air. The only feasible system appears to consist of a storage reservoir above the level of the tidal basin. Whenever the output of the primary turbines exceeds the industrial demand, the excess energy is utilised to pump water into the reservoir, and when the demand exceeds the output from the primary turbines it is supplied by a series of generators driven by a battery of secondary turbines operated by the water from the storage reservoir.

Evidently this method is available only when the physical configuration of the district affords a suitable reservoir site within a reasonable distance of the tidal basin. Unfortunately, also considerable losses are inevitable in the process. Where two tidal schemes at some distance apart differ sufficiently in phase, it is possible to work the two in conjunction, but this does not affect the necessity of storage as between spring and neap tides.

The prospects of tidal-power schemes would be much more promising if the whole of the output could be utilised as it is generated. By feeding into a distributing main in conjunction with a large steam station and/or inland water power scheme, and delivering to an industrial district capable of absorbing a comparatively large night load, such a state of affairs might be realised, at all events approximately. There is also the possibility that the intermittent operation of certain electro-chemical processes may be developed so as to enable any surplus power to be absorbed as and when available, and, if so, power developed tidally will probably prove cheaper in this country than that developed from any other source.

Owing to the relatively large variations in working head in any simple scheme, and to the small working heads, the design of hydraulic turbines capable of giving constant speed with reasonable efficiencies, and of moderately high speeds of rotation, is a matter of considerable difficulty. Modern developments, however, promise much better results in both these respects.

Even with such turbines, the number of technical problems to be solved before a tidal scheme of any magnitude can be embarked upon with confidence is large. The questions of single *versus* double-way operation, of storage, of the effect of sudden changes of water-level due to strong winds, of wave effects, of silting in the tidal basin and of scour on the down-stream side of the sluices, of the best form of turbine and of generator, and of their regulation and of that of the sluice gates, are probably the most important, though not the only, subjects to consider.

On the other hand, the possibilities of tidal power, if it can be developed commercially, are very great. Assuming a mean tidal range of only 20 ft. at springs and 10 ft. at neaps, and adopting the single-basin method of development with operation on both rising and falling tides, each square mile of basin area would be capable, without storage, of giving an average daily output of approximately 110,000 H.P. hours. In such an estuary as the Severn, where an area of 20 square miles could readily be utilised with a spring tidal range of 42 ft., the average daily output, without storage, would be approximately 10,000,000 H.P. hours.

At the present time it is difficult to obtain even a rough estimate of the total cost of such a scheme, owing to the uncertainty regarding many of the factors involved. The whole question would appear to merit investigation, especially on matters of detail, by a technical committee with funds available for experimental work.

BOILERS ON SINKING SHIPS.

By Edward Ingham.

The question, "What happens to the boilers when a steamship sinks?" is one on which some rather peculiar notions appear to be held. Probably the most common belief is that the boilers explode immediately the ship disappears beneath the waves. This belief is strengthened by the fact that the sinking of a steamship is usually accompanied by the escape of large volumes of steam. The escape of the steam is easily accounted for. When the stokehold becomes flooded the water comes in contact with the fires in the boiler furnaces, and large volumes of steam are immediately generated in consequence.

Explosion or Collapse.

Whilst some believe that the boilers explode, others hold a different opinion, maintaining that collapse, rather than explosion, takes place. Their theory is that when the boilers become submerged the cold water which envelops them condenses the imprisoned steam, thus producing a partial vacuum, with the result that the greater external pressure causes the comparatively thin shell to collapse. It is generally recognised that a large, thin cylindrical vessel, such as a marine boiler, is very weak to resist collapse.

This theory seems tenable, but there is good reason to believe that collapse does not take place in the manner referred to. It must not be forgotten that the boilers are covered with an efficient non-conducting material, whose function is to prevent, as far as possible, loss of heat by radiation. Obviously, this non-conducting covering will tend to prevent condensation of the steam in the boilers, and the consequent formation of a partial vacuum; indeed, a considerable time would elapse before the pressure could become reduced to a serious extent.

As a matter of fact, long before any appreciable reduction of pressure could take place, collapse of the boilers would be brought about in an entirely different manner. A few seconds after the ship disappears in deep water, a depth will be reached where the pressure of the water is so great that the boiler shells become crumpled up like matchwood, even if the internal steam pressure, which tends to prevent collapse, is maintained.

Relative Pressures.

Since a column of water one foot high and one square inch in sectional area weighs ·434 lb., it will be seen that at a depth of 100 ft. the pressure of the water will be 43·4 lb. per square inch. Imagine this pressure acting over the whole of the shell of a large cylindrical boiler, perhaps 12 ft. or 15 ft. diameter and 20 ft. long, and one can gain some idea of the enormous force tending to crush the shell.

The pressure increases in proportion to the depth of the water, and a ship sinks with increasing speed, so that very little time elapses before the total crushing force becomes sufficient to cause the collapse of the strongest boilers.

In the case where a ship is sunk in comparatively shallow water, it may be that collapse of the boilers will not result immediately, owing to the fact that

the steam pressure has not become appreciably reduced, and the preponderance of the total external over the total internal pressure is insufficient to cause failure. As, however, the steam pressure is gradually but surely dying down, ultimate collapse is inevitable, and the boilers are finally reduced to shapeless masses of crumpled steel.

AEROPLANES FOR COMMERCIAL PURPOSES.

STRIKING DISPLAY AT LONDON EXHIBITION.

THE Aero Exhibition closed at Olympia, on the 20th. What struck one on entering the spacious building was the immense space occupied by what are rapidly becoming known as the commercial types of aeroplanes. Wings and bodies are of enormous dimensions when seen close at hand, as they can be here, and when one peers into the sumptuous "cabins," which in some cases can house 25 passengers, besides the driver, pilot, etc., one is impressed by the wonderful strides which the science of air navigation has made during the past few years.

Take the Vickers-Vimy Commercial; it has a cabin with armchairs fitted on each side, with a central gangway. From large windows the passengers have a complete view of the panoramic scenery through and over which they may be passing, and there is also ample accommodation for luggage in special cupboards. The plane has two 360-H.P. Rolls-Royce engines, developing a speed of 100 miles per hour, and can carry 10 passengers and two pilots, or 1½ tons of freight.

Another aerial marvel is the Handley-Page W.8, this year's model. With two Napier engines of 450 H.P. each she can carry 1½ tons, equal to 26 passengers. The saloon is inside the fuselage, and has velvet-cushioned armchairs so arranged that each of the passengers has a window through which he can view the scenery as the machine wings its way through the air.

On a less ambitious scale is the Sopwith Gnu, a light aeroplane for the transport of passengers or goods. It is a useful intermediate between the fast single, or two-seater, and the heavy weight-carrying aeroplane. It has a cruising speed of 80 miles per hour, with a maximum of 110 miles per hour.

To meet the demands for a commercial aeroplane of low capital cost and maintenance, Martinsyde Ltd. have produced a machine to seat four passengers and pilot, with provision for hand luggage. It is fitted with a 300-H.P. Hispano-Suiza engine, and has a cruising speed of 100 miles per hour. By means of floats, the machine can be converted into an efficient seaplane. The same firm also show a two-seater, which is ideal for postal and commercial purposes, where high speed is desired.

An all-metal aeroplane is exhibited by Short Bros. Ltd., a single-seater, designed to carry freight to the amount of 400 lbs. Otherwise this space could be designed for two passengers. The engine is a Siddeley Puma, and no wood or fabric is used in the construction of the machine.

Of an attractive type also is the Supermarine "Channel Type" commercial flying boat, made by the Supermarine Aviation Works Ltd. With a 160-H.P. Beardmore engine, it can carry three passengers and pilot, or 540 lbs. By reducing the passenger space by one, the machine can be fitted with amphibian landing gear. This gear lifts clear of the water, and can be lowered and raised into position by the pilot during the flight.

Apparently special efforts have been made by the British Aerial Transport Co. Ltd. to provide an aeroplane suitable for carrying goods or passengers, due regard being paid to the possibility of selling the machine at a moderate price. This, they believe, they have attained in their B.A.T. "Commercial Mark 1," which can take a load of 1,000 lbs. with sufficient fued to afford her a range of 660 miles at a cruising speed of 110 miles per hour. A remarkable feature of this machine is the cabin, which is 8 ft. long by 6 ft. high, and 3 ft. 3 in. wide, and this has been attained without sacrificing any of the constructional strength of the fuselage wherein the cabin is situated. The machine has a Rolls-Royce Eagle VIII. engine, and four passengers can be carried, with ample room for personal luggage. Considering that the overall length of the machine is only 34 ft., the cabin and cargo accommodation is surprisingly large.

Fitted with a Siddeley Puma engine, the Avro Commercial Triplane, made by A. V. Roe and Co. Ltd., is claimed to be a commercial machine in every sense of the word, and is said to be both reliable and economical. A roomy cabin, fitted like a railway carriage, seats four passengers, but, if goods are to be carried, these seats can be removed, leaving 113 cubic feet available.

A Blackburn "Swift," by the Blackburn Aeroplane and Motor Co. Ltd., is a machine embodying experience gained during the war, and the display by William Beardmore and Co. Ltd. is of much interest to traders, comprising, as it does, among others, two commercial aircraft. The engine fitted to the W.B.2 is the Beardmore 6-cylinder vertical, 160 H.P. or 200 H.P. as required. The W.B. 10 was designed to meet the requirements of the Air Ministry Competition this year. It will carry a passenger or cargo up to 200 lbs., but this can be increased to 500 lbs. with a small reduction in speed.

For pleasure or business purposes the Austin Motor Co. Ltd. show the "Austin Whippet" single-seater biplane, which has a 45-50 H.P. Anzani engine, with sufficient fuel for a two-hours flight.

Among commercial seaplanes, the "Centaur 4B" 3-seater, made by the Central Aircraft Co., has attracted many visitors. It has an Anzani 100-H.P. motor, and has been constructed to withstand hard wear and rough usage. The machine leaves the water after a run of about 500 yards, with a full load, even in a flat calm with a smooth sea.

Some of the Armstrong-Siddeley Motors Ltd. engines were a source of great interest to aircraft engineers, and among other exhibitors who ought to be mentioned are the Sunbeam Motor Car Co. with a fine array of aircraft engines; the British Thomson-Houston Co. Ltd., with magnetos, electric bulbs and fabroil pinions; the Palmer Tyre Co. Ltd., one of whose cord tyre machines was constantly at

work showing the closeness and efficiency of this method of clothing the cover of a wheel.

The Hoyt Metal Co. of Great Britain Ltd. showed anti-friction metal for various types of aircraft and other engines; Thos. Firth and Sons Ltd. had a varied display of steel bars and sheets, and air-hardening and oil-hardening nickel chrome steels; four types of aero engines which bear the name of Rolls-Royce were exhibited on a special stall; Gwynne's Engineering Co. Ltd. also invited attention to their Clerget and other engines; and D. Napier and Son Ltd. displayed with pardonable pride engines which have many records and unique performances to their credit.

With space for goods or three passengers, the Westland Aircraft Works produced an aeroplane fitted with a 300-H.P. Hispano-Suiza engine, one of the features being a fireproof bulkhead between engine and fuselage.

In the gallery of Olympia the Air Ministry had a special section, which comprise some of the latest devices for ensuring safety and reliability in the matter of flying generally. Tests are made by the Ministry in almost every conceivable direction, including all metallic and non-metallic materials. The results of some of these rigid tests can be seen, and prove that every effort is being made by the department to lift the science of flying to the extremest point of absolute safety.

Altogether the Exhibition is a proof of the actual utility of aviation as a commercial proposition. The outstanding feature of the show is, as we said in the beginning, the display of what can be done in the matter of providing commercial aeroplanes capable of carrying goods. Big firms can, of course, command big machines to carry big cargoes, but there is nothing to prevent the smaller men, who in their way are equally ambitious traders, from utilising the services of one or two-seater planes with a useful cargo-carrying capacity, and thus getting over one of the present-day difficulties in the matter of train and road transport, which is hampering commerce in every direction in these islands. For overseas trade there is nothing to prevent the development of a substantial and increasing trade between Great Britain and the Continent. The machines are there, and the makers claim that the prices and the cost of maintenance are reasonable, if not extremely low, and it is for traders generally to consider the utility and profit which lie before them in the new sphere of commerce which aviation has undoubtedly opened up to them.

"BRISTOL" AEROPLANES.

Finality in aeroplane design is probably far off, but it is even now possible to travel in luxury and with a high degree of safety by air. Fig. 1 shows passengers boarding a "Bristol" Pullman triplane. Fig. 2 is a view of the same machine in flight, and Fig. 3 is a side elevation which also illustrates the construction of the fuselage and the arrangement of the fauteuils, which, although removable, are nominally placed on either side of the car with a gangway down the centre. This triplane accommodates 14 passengers, in addition to pilot and engineer, and is well heated, lighted and ventilated.

When not carrying passengers it has a total space

Fig. 1.

of 570 cubic feet available, and a lifting capacity of 2,700 lb. with fuel for a five hours' flight, or

Fig. 2.

4,000 lb. with fuel for a $2\frac{1}{2}$ hours' uight. Although the maximum speed obtainable with its four 410 H.P.

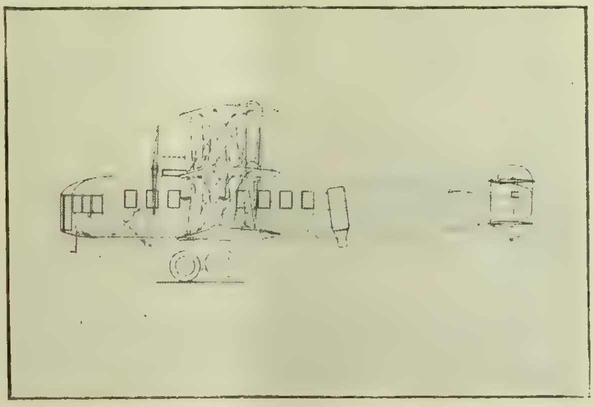


Fig. 3.

engines is 135 miles per hour, its economical cruising speed with the engines at half throttle is about 100 miles per hour.

By comparison with the "Pullman" triplane, with its great wing span of 80 ft. and overall length of 52 ft., the "Bristol" three-seater coupe tourer (Fig. 4) is small, but it is a machine of high performance. The coupe, with which it is fitted, protects the

FIG. 4.

passengers from the weather, and is thus an improvement on the same firm's machines used by the Instone Air Line, and is so streamlined as not to interfere with the machine's progress in flight. The engine develops 240 B.H.P., with dual ignition by two six-cylinder magnetos.

ENGINEERS' WAGE CLAIMS.

THE award of the Industrial Court in regard to the claims of the Unions connected with the engineering, foundry, and shipbuilding trades for an advance of 6d. an hour, has decided that the claims submitted have not been established. The claims of the workmen were supported principally on the grounds that the cost of living had increased since the date of the last general advance. On behalf of the employers it was submitted that the total advances given were adequate to meet the increase in the cost of living which had occurred since the outbreak of war, and that the commercial position was such that a further advance in wages would be accompanied by grave risks of injury to the trade.

The Court expressed the view that in ordinary circumstances the value of work done in relation to the state of trade was the most important consideration, and held that while the state of trade, as evidenced by the published returns, is still good, yet, from the information submitted by the employers, there were indications of a falling off in demand in some branches of the industry.

Applications for special advances in accordance with the second paragraph of clause (1) of the agreement of February, 1917, have still to be considered.

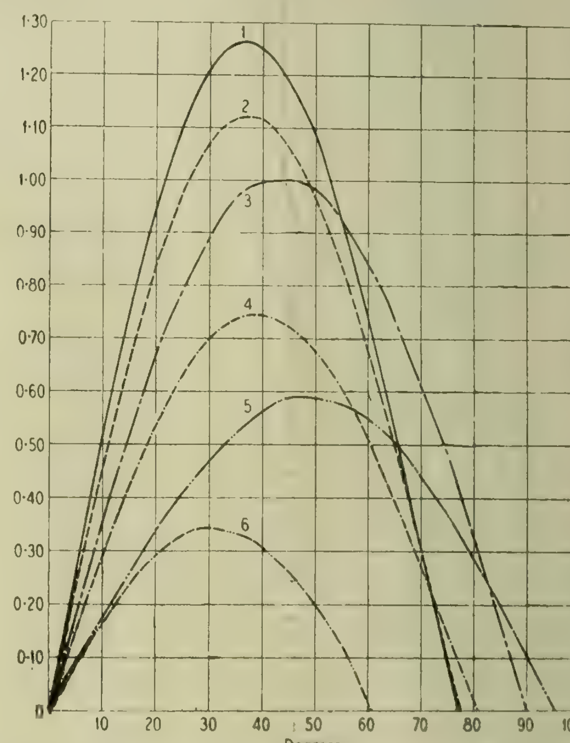
THE Industrial Council has turned down the application of the Manchester and district engineers for an advance of 6d. an hour. In view of the decision with regard to the national application, this was not unexpected. Although the main claim was for an advance of 6d. an hour, there were subsidiary claims, including a standard wage of £6 a week and the doubling of rates of pay, including overtime pay, for week-end work.

INERTIA TORQUE IN CRANKSHAFTS.

(*Continued from page 377.*)

Effect of Rod Length.

In Fig. 5 a series of inertia torque curves is shown for a single line of parts with various values of connecting-rod/stroke ratio, and it will be seen that the maximum peak values approximately follow the same law as the maximum peak for linear inertia—that is to say, for a single line of parts a fairly considerable improvement as far as this torque is concerned may be obtained by lengthening the rod. But when we come to the case of the four-cylinder engine, the difference in the resultant maximum values of K in the last journal is only 0·2 per cent between the case of a rod of infinite length and that of a four to one rod, a difference which is, of course,



The series of curves in this figure shows maximum peak of inertia torque curves for various types of twin-cylinder engines:—

1. Horizontal opposed—cranks at 180 degrees
2. Vertical—cranks at 180 degrees
3. Vee 22½ degrees—single crank
4. Vee 45 degrees— " "
5. Vee 60 degrees— " "
6. Vee 90 degrees— " "

FIG. 5.

negligible. On the other hand, the 90 deg. Vee type will be found to give a very big percentage improvement with increase in rod length, until in the case of the rod of infinite length the torque is zero at all crank angles, but the actual values are so small that even the shortest rod is not really detrimental in this case. The 60 deg. Vee type is very little improved by lengthening the rod, the maximum values of K being 0·590 and 0·500 for four to one and infinite rods respectively.

The conclusion therefore may be drawn that, as a general rule, the effect of connecting rod length may be neglected as far as the inertia torque is concerned,

and that the curves shown for a four to one rod ratio may be taken to apply to any engine regardless of the actual ratio. Of course, in the case of a rotary engine, rod length is a more serious consideration than the actual stroke.

The author cannot leave this portion of the subject without drawing attention to two facts which are common knowledge, but to which designers seem to attach comparatively slight importance. The first is that by fitting the longest connecting rods possible within practical limits a very appreciable advantage is gained not only in linear balance, but also in mechanical efficiency owing to the reduction in side pressure on the cylinder walls. The second is that

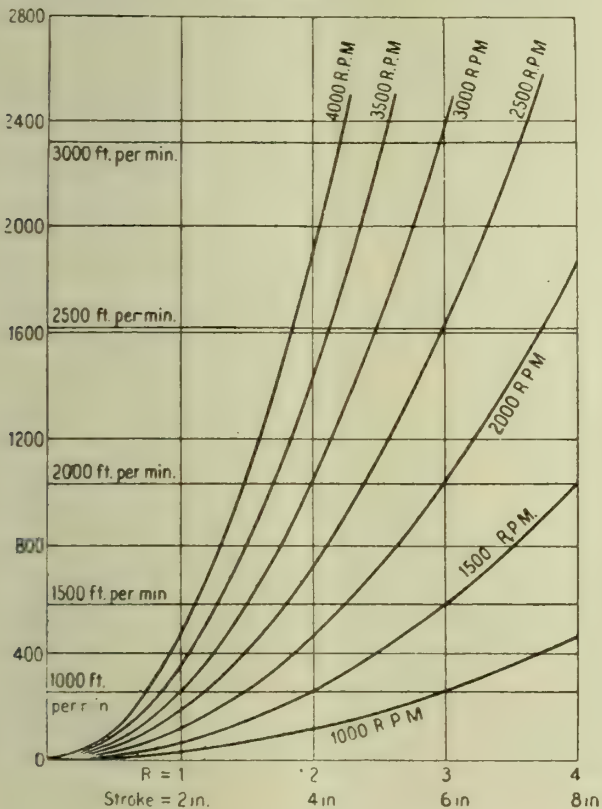


Fig. 6.—Values of $R^2.\omega^2/12g$.

when speeds are reached at which inertia forces become serious, the desaxé engine, especially with a comparatively short rod, is an absolute fallacy for reasons pointed out elsewhere in the paper.

Inertia and centrifugal forces undoubtedly play the greatest part in determining the mechanical efficiency of an engine, and it is therefore the author's opinion that many of the claims made by certain piston specialists may be traced much more readily to the actual weight of the parts than to any special virtue in the form of the bearing surfaces. Piston ring pressure also plays its part, as was very forcibly brought home to the author some years back when experimenting with various forms of ring. The lightest possible ring pressure is certainly the most efficient, both mechanically and as a seal.

Effect of Stroke Length.

Fig. 6 shows the value of $W.R^2.\omega^2/12g$ when $W = 1$ for various values of R up to 5 in., and illustrates how rapidly the inertia torque increases with both stroke and speed. The dotted lines across the figure represent piston speeds in feet per minute, and it will be noticed that these lines are parallel to the base line —that is to say, for a fixed speed the inertia torque varies as the weight of reciprocating parts only and is independent of the actual stroke.

(To be continued.)

Reviews.

ARMATURE WINDING. By C. Sylvester, A.M.I.E.E., A.M.I.M.E. London: S. Rentill and Co. Ltd. 7s. 6d. nett.

This is described as a practical handbook for students, armature winders, and engineers-in-charge. It is purposely written in a simple manner, and is elementary, its intention being primarily to explain the principles of winding that the armature winder, however good a craftsman he may be, will be able to take a more intelligent interest in his work, and be able to test and locate faults without assistance. A knowledge of principles not only makes for efficiency, but lessens the monotony of labour by making it more interesting. The book is illustrated by line drawings, there is a very good index, and it is divided into nine chapters. The first chapter is preliminary, and explains the action of the armature, direct and alternating currents. The second chapter, which is controversial, discusses winding shop equipment, the third considers the design of a small generator in order that the student may be acquainted with the circuits through an armature. The fourth chapter deals briefly, or comparatively so, with the hand-wound armatures, which have almost become obsolete. Chapter six concerns alternating current, way shapes and insulation. Chapter seven is devoted to rotary converters, principles of design, etc. Chapter eight deals at length with induction motors; and the last chapter discusses shop methods of testing and testing materials.

NOTES ON DYNAMICS, with Examples and Experimental Work. By T. Thomas, M.A., B.Sc., LL.B. 6s. nett.

Text books are generally so stereotyped in form that it is a pleasure to look at one which quickens the interest. This book does so. It is elementary, yet in the later chapters fairly advanced. It presupposes the student to have a considerable mathematical knowledge, and is based on the course intended for Woolwich and Navy candidates. There is not much scope for originality in definitions or statement of principles, but the author has contrived to state them very concisely. The major part of each chapter is taken up with examples for the student to solve, and at the end of the book a key to these problems is given. There are over 100 sketches in the 120 pages. Apart from the six chapters of actual text-book matter, there is a valuable section dealing with experimental work, which should teach the student to apply principles, and thus make his study of greater practical value. Thus the author explains how to find the brake horse-power of an engine and the height a ball must drop in order that it will loop the loop inside a circular piece of cardboard.

"WHO'S WHO" IN ENGINEERING. The Compendium Publishing Co. 25s. nett.

This volume supplies a long-felt want by engineers, and for a first annual is very complete. It is divided into several sections. While the "Personal and Professional" section is interesting, with its biographies of well-known engineers, with their qualifications and records clearly stated, the business part, which is in essence a directory of British engineering firms, and the index to manufactures, are specially useful. A short history of each firm is given, with the average number of men employed; its capital is stated, and the capacity of the works indicated. Appended to the work are lists of research bodies, associations of employers and employees, engineering institutions and journals, and engineering training centres.

Quite recently a committee of French experts visited the United States, and they have reported in favour of a considerable extension of railway electrification in France. They were so impressed with a system using 3,000 volts overhead conductors between Milwaukee and St. Paul, that probably a similar standard construction will be adopted in France.

Trade Items, Notes, &c.

The Société Industrielle de Products Chemiques is to increase its capital from four to eight million francs by the issue to present shareholders of 1,000 francs each at the rate of 1,050 francs.—Reuter.

Big Technical College Fire.—A fire, causing damage to the extent of £14,000, occurred in the Royal Technical College, Glasgow, recently. The flames were confined to a portion of the building used as a chemical store which contained valuable stock. The fact that the college is divided into fire-proof sections was mainly responsible for the conflagration not spreading.

Rails from America.—The Glasgow Tramways Committee has agreed to recommend that a contract for 10,000 tons of steel rails be given to an American firm at the price of £24 10s. per ton. Delivery is promised in November, and the price includes freight. The lowest and only British tender was from a Middlesbrough firm, who quoted £28 per ton. By giving the contract to America the Committee saves £35,000.

Big Wages Claim.—The Federation of Engineering and Shipbuilding Trades and the Amalgamated Engineering Union made the same claim recently as for the engineering and shipbuilding trades of 6d. an hour increase on time rates for adults, and 3d. per hour for juniors, with an equivalent advance for pieceworkers. The national Federation of General Workers claimed for the semi-skilled men an increase of £1 per week for adults and 10s. for those under 18.

Manchester Engineers : A Veto on Overtime.—The trouble in the engineering trade has led to the Manchester district members of the Amalgamated Engineering Union giving notice that on and after July 10th no overtime of any description shall be worked. This interdiction of overtime applies even to breakdowns, repairs to plant, and general maintenance work, and is to continue until "a satisfactory settlement is arrived at between the employers concerned and the union."

Crompton and Co.—Net profit of this firm of Chelmsford electrical engineers for the year to the end of March last was £52,878 against £38,828 for the preceding year. After deducting the interim dividend on the preference shares paid in January last, there remains £65,534. The directors propose to add £15,000 to the general reserve, to provide £9,000 for possible depreciation of investments, to pay another $6\frac{1}{2}$ per cent in the preference, making 10 per cent for the year on the ordinary.

To Direct State Factories.—Mr. H. Mensforth, general manager of the Metropolitan-Vickers Works, Westinghouse, Manchester, has been appointed Director-General of Government Factories, and will thus take over control of Woolwich, Enfield, and other armament factories on August 1st. Mr. Mensforth during the war was a member of many important local and national committees on armaments and kindred matters, and had the degree of Master of Science conferred on him by the Manchester University.

The Goetoverken shipbuilding yards at Gothenburg have completed the construction of the ocean-going vessel Elmaren, ordered by the Transatlantic Shipping Co. The Elmaren is the company's third motor vessel. Her register is as follows :—9,400 tons dead weight, 4,225 tons net, 5,700 tons gross. She is built for English Lloyd's highest class, and is fitted with two six-cylinder Diesel motors, which consume about 13 tons of oil daily. This is considered a very low figure compared with the consumption of coal by a steam engine of the same capacity, which amounts to about 55 tons daily.—Reuter.

The May "Heat Treatment Bulletin" issued by the Automatic and Electric Furnaces Ltd. takes the form of an interesting and informative article on pyrometers and pyrometry, which should prove valuable to users of furnaces. It is pointed out that the cause of trouble with pyrometers is due to weakening of the permanent magnet, which causes the indicator to change its calibration, and the results of exhaustive tests to determine the best metal or alloy for the wires are shown in two curve diagrams. The firm's address is Gray's Inn Road, London, W.C., and they would be glad if readers of this journal, who are on their monthly "Bulletin" mailing list, would notify them of change of address.

A Good Works Journal.—The works magazine is the triumph of those who believe that the social side of life has a considerable influence on the industrial side. It provides a common platform for employer and employee, not so much to discuss differences as to discover agreements and mutual interests. Some of these journals are merely a record of athletic events, while others deal too exclusively with production. Messrs W. Beardmore and Co.'s "News" does not do either. The June number of 46 pages contains a column of cookery hints, humorous sketches, an article on the history of airships, some technical matter, as well as news columns from the various works of the firm and associated companies.

Institution of Automobile Engineers.—The first meeting of the Institution for Session 1920–1921 will be held on Wednesday, October 13th, when Sir Henry Fowler, K.B.E., will give his presidential address. Subsequent meetings of the Institution will be held on the 2nd Wednesday in each month up to May 11th. The Birmingham meetings of the Institution will be held on Oct. 28th, Dec. 30th, Feb. 24th, and April 28th. The London Graduates meetings will be held on the second Thursday in each month, and the Birmingham Graduates on the third Wednesday in each month. The first annual dinner of the Institution will be held at the Royal Automobile Club, on Wednesday, October 27th, at 7-30 p.m., when it is hoped that a number of important guests will be present. The price of the tickets will be 17s. 6d. per head excluding wines. The dates of the Coventry Graduates meetings are as follows : September 28th, 1920, business meeting, November 2nd, 17th, and 30th, 1920; December 14th, 1920, January 4th and 18th, 1921; February 1st and 15th, 1921, March 1st and 15th, 1921; and April 5th, 1921.

Hydraulic Power in Tonkin.—The necessity for locall treating zinc ore has attracted attention to the adaptation an utilisation of the available hydraulic power here. Howevei such a step will not prove profitable unless such arrangement be made at once for the supply of a very considerable powei The very lowest power that it would pay to instal must nc be less than 30,000 H.P. This, however, is certainly too muc for the local zinc producers, who require a much smaller powe, say, about 10 times less, but the surplus could well b employed for irrigation purposes. The 30,000 H.P. plant proposed to be installed at Chobo, and could thus irrigate the tw groups of land on the Red River. Should there be any powe available after this supply, it would be used in connectio with the production of calcareous cyanide, which is no attracting attention as a substitute for nitrogenated manure The carbide of calcium, upon which the production of th product is based, is found at Chobo in great abundance. Japa and Dutch East Indies now consume about 200,000 tons o cyanide.

A Novel System of Aerial Railway.—It is stated by *L'Eclaireur*, of Nice, that a novel system of aerial travel ha been invented by M. Henri Coarda, a well-known Frencl engineer. The plans for the construction of the first line t be constructed in the Department of the Alpes Maritimes have already been submitted to the Prefect for authorisation. The new system to be adopted consists, mainly, in establishing a fixed cable line between the two extremities. From this cable, to be supported at a suitable height above the ground by posts, placed at intervals, will be hung specially constructed avions or aeroplanes, to serve as passenger cars. These, which will be quite independent of each other, will serve as the passenger cars. They will be provided with the usual screw propeller, and planes or wings, as in use for independent aeroplanes. They will be driven in the usual way by a motor at a speed of about 150 kilometres per hour (about 100 English miles). M. Coarda proposes to construct a first and trial line from the sea-coast at Meulon to Piera Cava, a well-known summer resort, about 30 miles to the North-East of Nice, and at 1,500 metres (4,800 ft.) altitude. The total length of the proposed line from Meulon will be about 36 kilometres (22 miles), and it is estimated that the journey would occupy about 25 minutes.—*Journal of the Royal Society of Arts.*

British Thomson-Houston. The directors of the British Thomson Houston Co., which owns rights in respect of electric lighting, traction, and power transmissions, report for the year

1919 a profit of £412,399, which, with £150,863 brought forward, makes £563,262. Interest on debentures and loans absorbs £134,230, and the directors recommend that out of the remaining £429,032, a sum of £220,601 be appropriated to depreciation reserves and adjustments, and that the balance of £208,430 be carried forward. The capital reserve has been increased from £245,554 to £251,772, and the directors recommend that out of this reserve there be paid the accumulated dividends on the preference shares, amounting to £210,000 (being £5 5s. per £10 share), and to the ordinary shareholders £40,000 (being £1 per £10 share). It is proposed to capitalise this £250,000, and to issue fully paid ordinary shares to that amount to the shareholders. No dividend has been paid on the ordinary shares since 1903. It is also proposed to increase the share capital from £800,000 to £4,000,000, half in £1 ordinary shares and half in £1 preference shares. Of the two million ordinary shares 400,000 will replace the existing 40,000 £10 ordinary shares, and 400,000 the existing £40,000 £10 7 per cent cumulative preference shares.

Machine Tool Exhibition.—"The Coventry" Chain Co. Ltd., Spon End Works, Coventry, manufacturers of high-duty, high-precision driving chains, will have an exhibit which will consist of a "Coventry" chain reduction box and a "Coventry" chain drive in motion, together with specimens of "The Coventry" inverted tooth (noiseless), and "The Coventry" roller chains, suitable for all kinds of transmissions, such as mainshafts, lineshafts, machine tools, pump fans, air compressors, stokers, conveyors, elevators, winches, planing machines, metal saws, looms, etc. The exhibit of the "The Coventry" Repetition Co. Ltd., Coventry, comprises an assortment of small instrument screws, up to large component parts, turned from the bright bar, in mild or alloyed steels and non-ferrous metals; bolts, nuts, washers, studs, pins, set screws, countersunk, roundhead and cheesehead screws, shackle bolts, gudgeon pins, tappets, collar screws, and large turned work, as supplied to the leading firms in the motor, aircraft and general engineering industries. Enquiries invited. Quotations given from blue prints or samples. All enquiries receive the personal attention of the management.

Vickers Ltd.—The well-known firm of Vickers Ltd. is offering £1,500,000 7 per cent seven-year notes to bearer, at 95 per cent, repayable at par on July 1st, 1927. The works of the company were, in the national emergency, continuously engaged on the production of material necessary for the successful prosecution of the war, and although since the armistice, owing to the many complicated matters requiring adjustments with various Government departments, it has not been found possible to produce the completed accounts for the years 1916, 1917, 1918, and 1919, the dividends for those years were paid with the approval of the company's auditors. From figures which it has been found possible to compile, the capital expenditure up to the end of 1919, at book value, and interest in subsidiary and connected companies, and marketable securities, amounts to £24,767,000. So far as can be ascertained there was, in addition, a surplus of cash, stocks, work in progress, and book debts after deduction of liaibilties, of £4,216,000. No goodwill or patent rights are taken into account. From 1910 dividends varying from 10 per cent up to 12½ per cent, free of income tax, have been paid. The proceeds of the present issue will be used for the extension of the company's business, and in particular its large electrical interests. The yield on the notes, after allowing for the profit on redemption, is £7 18s. per cent per annum.

Diesel Engine Users' Association.—The Diesel Engine Users' Association, at their June meeting, discussd the proposed Research Association for Liquid Fuels. Mr. Napier Prentice, who is chairman of the Provisional Committee of the Research Association for Liquid Fuels, read a report which had been prepared by Mr. Percy Still, who is acting as hon. secretary of the Provisional Committee. This referred to the difficulties which had been experienced and partly overcome during the war in connection with the use of tar oil fuel in Diesel engines, and to the importance of obtaining further information by systematic research with a view to the possibility of the more extended use of home produced fuel in Diesel or Semi-Diesel engines. Mr. A. Abbott, of the Department of Scientific and Industrial Research, addressed the meeting on the subject of the General Scheme of a Research Association. He spoke of the work being carried out by the Fuel Research Board, the scope of which covered the scientific investigation of the whole of the problems relating to the use of fuels, whether solid, liquid, or gaseous, and he added that the Director of Fuel Research was of opinion that research work carried out by an association having for its object the investigation of the use of liquid fuels in Diesel and Semi-Diesel engines would be of great value, and that this would not lead to any overlapping of effort.

Institution of Automobile Engineers. What is undoubtedly the most successful visit ever arranged by the Institution of Automobile Engineers has just come to an end. Well over 100 members met at Derby on June 22nd, and were shown over the Rolls-Royce Works in the morning, where the members were impressed by the extraordinary care taken in the fitting of every item, and the amount of human skill which is relied upon in the production of this car. After being entertained to lunch by the directors of the Rolls-Royce Co. they were shown over many departments of the Midland Railway Co.'s locomotive works, and subsequently entertained to tea by the president-elect, Sir Henry Fowler, K.B.E. The 23rd and 24th inst. were spent in Sheffield, where the following steel makers kindly threw open their works for the inspection of the members: J. H. Andrew and Co. Ltd., J. Brown and Co. Ltd., Cammell, Laird and Co., Firth Derihon Stampings Ltd., Jonas and Colver Ltd., A. Lee and Sons Ltd., Sanderson Bros. and Newbould Ltd., Steel, Peech and Tozer Ltd., Edgar Allen and Co. Ltd., Brown, Bayley's Steel Works Ltd., Thos. Firth and Sons Ltd., Hadfields Ltd., Kayser, Ellison and Co. Ltd., G. Turton, Platts and Co., Ambrose Shardlow and Co. Ltd., and Vickers Ltd. It is impossible to detail all the processes which were inspected, but there is no doubt that the visit to this city has had most valuable results in bringing the automobile engineer and the steelmaker into close personal touch, so that the solution of difficulties with which each may be confronted will be much more easily arrived at in future than has been the case in the past where the relationship has been so largely impersonal. On the afternoon of the 24th the members rested from their labours and were entertained to a garden party by Mr. W. Clark, J.P., at Whiteley Wood Hall. On the 25th the members first visited the works of Messrs. Crossley Motors Ltd., in Manchester, and were conveyed thence in a fleet of some 30 Willys Overland/Crossley cars to the large factory at Heaton Chapel, which is now being used for the assembly of these cars. After being entertained to luncheon by the company, the party made a short inspection of the works of the Ford Motor Co., which brought the visit to a conclusion.

Patent Applications.

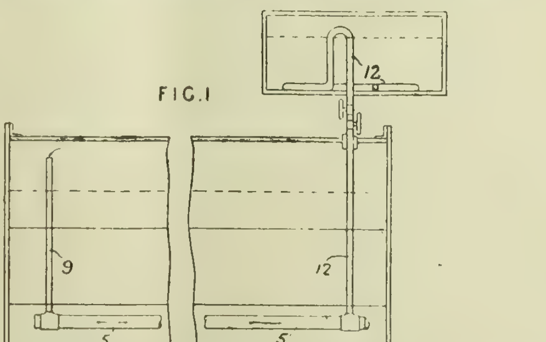
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

STEAM-GENERATORS.

130,133.—G. Grundy, 7, Green Lane, Sheffield.—July 20th, 1918.—The water at the bottom of a boiler is heated by two steam pipes 5 conveying steam from the boiler steam space into a feed tank

FIG. 1

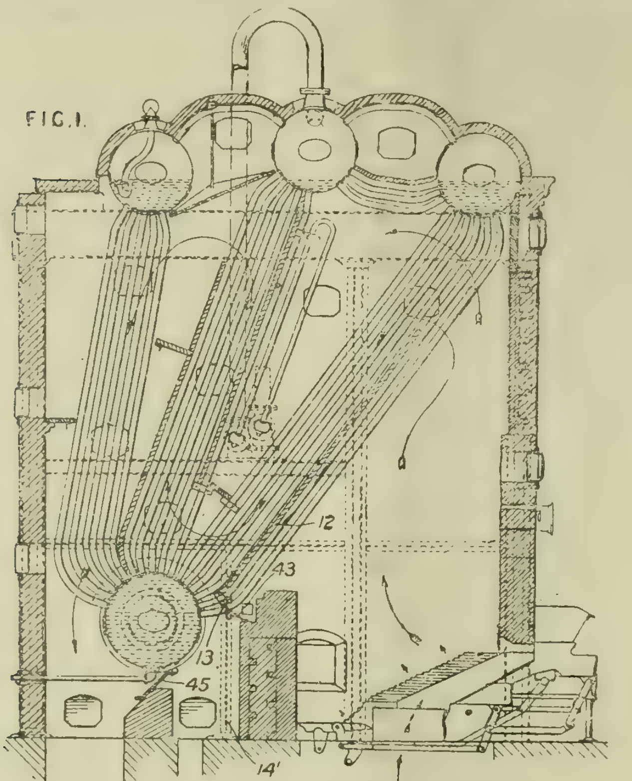


or the like outside the boiler or into another boiler. A pipe 9 opening into the steam space and a pipe 12 passing upwards into the feed-tank are connected to transverse pipes opening into each end of the steam pipes.

STEAM-GENERATORS.

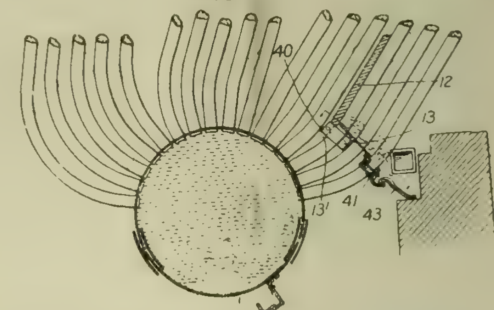
129,418.—H. G. C. FAIRWEATHER, 65, Chancery Lane, London. (Babcock and Wilcox, New York, U.S.A.)—July 6th, 1918.—In a boiler comprising upper and lower drums connected by banks of

FIG. 1.



tubes, more particularly in a boiler of the Stirling type, a cross-baffle 13 and a yielding seal 43 extend from the bottom of a longitudinal baffle 12 in the front bank of tubes to the bridge wall. An opening 13' is left between the cross-baffle and the lower drum to allow soot and ashes to fall into a pocket 14' behind the bridge. The cross-baffle is formed of a number of removable parts having recesses engaging with the tubes, and is supported by clamps 40, 41 on the tubes. The plates are covered with ganister and fire-clay or similar material. The seal consists of

FIG. 4



a number of overlapping plates resting on the bridge and on lips projecting from the clamps 41. A similar seal 45 may be placed at the bottom of the drum. The plates forming the baffle may overlap one another at their edges.

INTERNAL-COMBUSTION ENGINES.

131,529.—E. Russell, 49, Kedleston Road, Derby.—Dec. 14th, 1918.—Aluminium cooling pins 5 are attached to the iron or steel

FIG. 2.

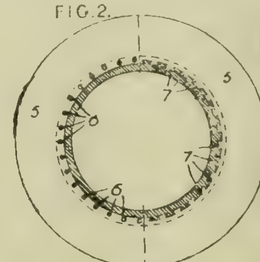
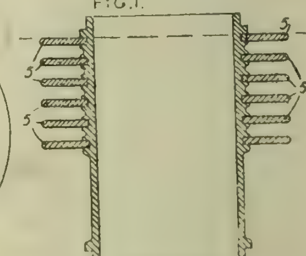


FIG. 1.



cylinder barrel by embedding them in the mould and casting the barrel around them. Their inner edges are perforated as shown at 6 or notched as shown at 7.

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—— THE ——

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CONTENTS.

EDITORIAL.

A THREE MONTHS INDUSTRIAL REVIEW.

THE quarterly surveys of the Board of Trade have proved more interesting reading since the Armistice than they ever were before. This is accounted for by the anxiety occasioned by our earnest desire to return to normal conditions. Pre-war conditions we do not hope for for many years to come, but the nearer we get to the pre-war ratio of values the more stabilised will industry become. The survey of the months, April, May, and June, is not depressing; industry and commerce on the whole have improved, but the improvement has been of a less decided character than that shown in the first quarter of the year. The engineering and metal trades are reported to be still unable to meet the demands, but this is qualified by the rather sinister indications that while shipping tonnage under construction and launched has increased month by month, there has been a considerable fall in the number of vessels commenced. This appears to confirm the statements that were made before the Industrial Court during the hearing of the recent wage application that owners were cancelling orders. It is evident that quieter times are ahead for the shipbuilding industry, but it is gratifying to learn that we are at present constructing 45 per cent of the world's shipping, as compared with 30 per cent twelve months ago.

Coming to the key industries of coal, iron, and steel, decrease in coal production monthly by nearly 5 per cent is disturbing. Fortunately, the production of pig-iron has gone up to 712,000 tons a month, or more than 43,000 tons above the monthly average for the first quarter of the year, while the output of steel (in ingots and castings) is greater than before the war, averaging 828,000 tons a month, while the figure throughout 1919 was 657,000 tons. It falls, however, far below the estimated productive capacity of the country, which is 1,000,000 tons a month. One can conjecture the causes for the discrepancy between the actual production and what is possible. It is highly essential for the national well-being that the output of coal, iron and steel should be greatly improved, as the prosperity of the metal trades hinges on this to a very great extent.

Unemployment reflects very fairly the condition and prosperity or otherwise of industry. Unfortunately, the *Board of Trade Journal* review merely gives the figures embracing all the trades that come under the Unemployed Insurance Acts. Consequently, it is difficult to sort out the position of the engineering industry at the end of June. Furthermore, unless we are greatly mistaken, the figures for July will show a much larger proportion of unemployed than those of June. The percentage of unemployed in the insured trades fell from 3·47 per cent to 2·64 per cent during April. But during early May the percentage increased, and at the end of the month, a slight improvement having taken place, it stood at 2·54 per cent. At the end of June, however, it had only dropped to 2·51 per cent. The deduction we draw from this is that industry was tending to ease gradually, right through the quarter, although it has to be remembered that the percentage given includes others, as well as engineering workers.

ELECTRIC TRUCKS AND THEIR OPERATION.

By E. Austin.

The immense advantages that are to be derived from the use of electric trucks in engineering and other factories are rapidly being recognised. Trucks of this sort enable articles such as rough and finished castings to be shifted from place to place with ease and with small expense, whereas manually-operated trucks are slow and costly. For transport work between different departments of a factory, or between different machines, or in yards, these small electrically-operated vehicles are very suitable, and within recent years a great many have been put into use. An efficient service of electrically-operated trucks in factories reduces congestion in the shops, and enables the different departments to be constantly supplied with parts passing through the processes of manufacture.

Fig. 1.—A Low Platform Truck Built by Ransomes, Sims & Jefferies.

Trucks with Low Platforms.

Various kinds of these trucks are now available, but one of the most common types is that shown in Fig. 1, which is a truck made by Ransomes, Sims & Jefferies. The platform, it will be noticed, is very near the ground, thus enabling heavy articles to be loaded with a minimum amount of difficulty, and also facilitating the transportation of bulky materials. The battery, which is capable of storing sufficient current to run the truck for 20 miles, is contained in a box on the front of the chassis just behind the driver, an arrangement which is essential to enable the carrying platform to be near the ground. Other types of trucks are, however, made. Another type truck, for instance, is fitted with three wheels, and is particularly well suited for operation on uneven roads and in places where a small turning radius is requisite. On the "Orwell" electric trucks, made by Ransomes, Sims & Jefferies, the reversing switch is operated by a handle on top of the controller, but the speed-controlling drum, which is inside the controller, is operated by a foot pedal, which, when depressed, releases the brake, which acts upon one of the driving wheels, but as soon as the pedal is released the brake is again applied and the current interrupted. Another brake acts on a small pulley at the end of the lay shaft. Steering is done by means of a handwheel or tiller acting on the centrally-pivoted steering wheels. The control gear is designed so that when the driver has mounted the driving platform or "step," to be seen in Fig. 1, he must first turn the main switch from the "off" position to the position which gives forward or backward motion, according to the direction in which he desires to travel, and not until this has been done can he depress the pedal which switches the current on to the motor and controls the speed. But once the main switch on the controller has been set, all the driver has to do to vary the speed or stop the truck altogether is to vary the pressure on the foot pedal. Electric trucks can, of course, haul trailers, and when fitted with flanged wheels they can run on rails, but in the

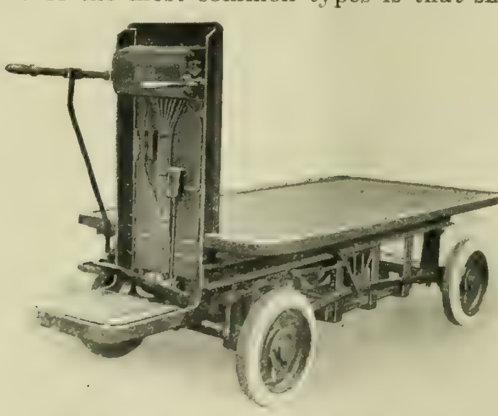

Fig. 2.—A 15-cwt. Electric Truck built by British Electric Vehicles Ltd.

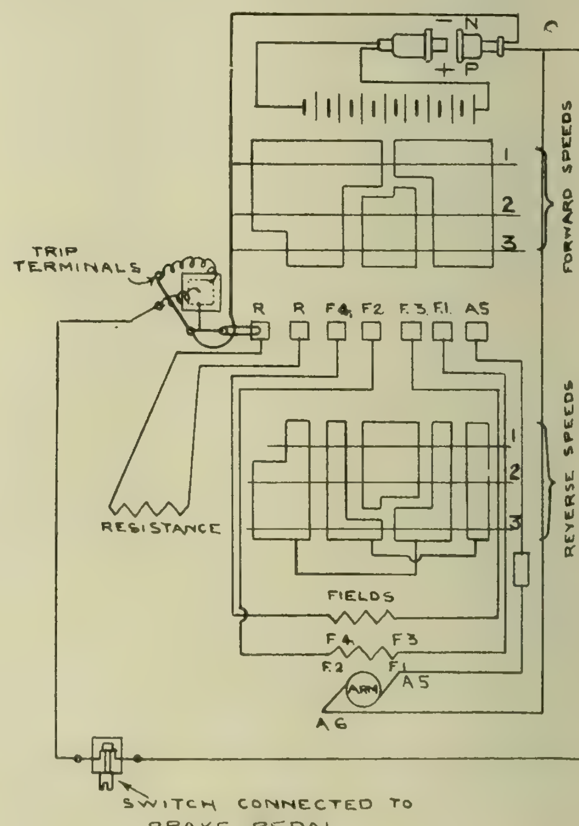

Fig. 3.

great majority of cases industrial trucks are fitted with rubber tyres to enable them to travel on ordinary floors.

Some Other Types.

No attempt will be made in the present article to describe all the electric trucks now on the market, but attention should, nevertheless, be directed to one or two of the leading types. Trucks of various capacities are made by British Electric Vehicles Ltd., and a 15 cwt. truck, with a loading space of 6 ft. by 3 ft., is shown in Fig. 2. The speed in this case is controlled by a handle which is fitted with a push button for controlling an electric bell. From the diagram of connections, Fig. 3, it will be perceived that the controller gives three forward and reverse speeds, which are obtained by means of the resistance and by series parallel grouping of the field coils. It will also be noticed that there is a switch connected to the brake pedal, so that the brake cannot be applied whilst current is passing into the motor. When the pedal is depressed current passes through the switch to the controller, and at the same time the brakes are released; but, of course, the truck does not start until the controller handle is shifted to the starting position. The circuit is made and broken by means of a magnet trip switch, indicated on the left of the diagram, Fig. 3, and the function of this switch is to prevent sparking at the main contacts of the controller.

Crane Trucks and Locos.

An extremely useful type of truck for factory service is the "Hunt Crane" truck, supplied by Messrs. Irwin & Jones, and as shown in Fig. 4. A truct of this sort may be used with great advantage for carrying castings, etc., to machines. With the aid of the electrically-operated jib crane, castings can be lefted from the floor on to the carrying platform, and from the platform on to the tables of machine tools, such as planing machines, boring mills, and so forth, or work can be lifted into position on lathes, etc. The delays which frequently arise in waiting until the overhead travelling crane is disengaged are, therefore, eliminated. A separate motor is fitted for working the crane, but the travelling and hoisting motors are both supplied with current from the same battery, which is situated just behind the driver's platform. The

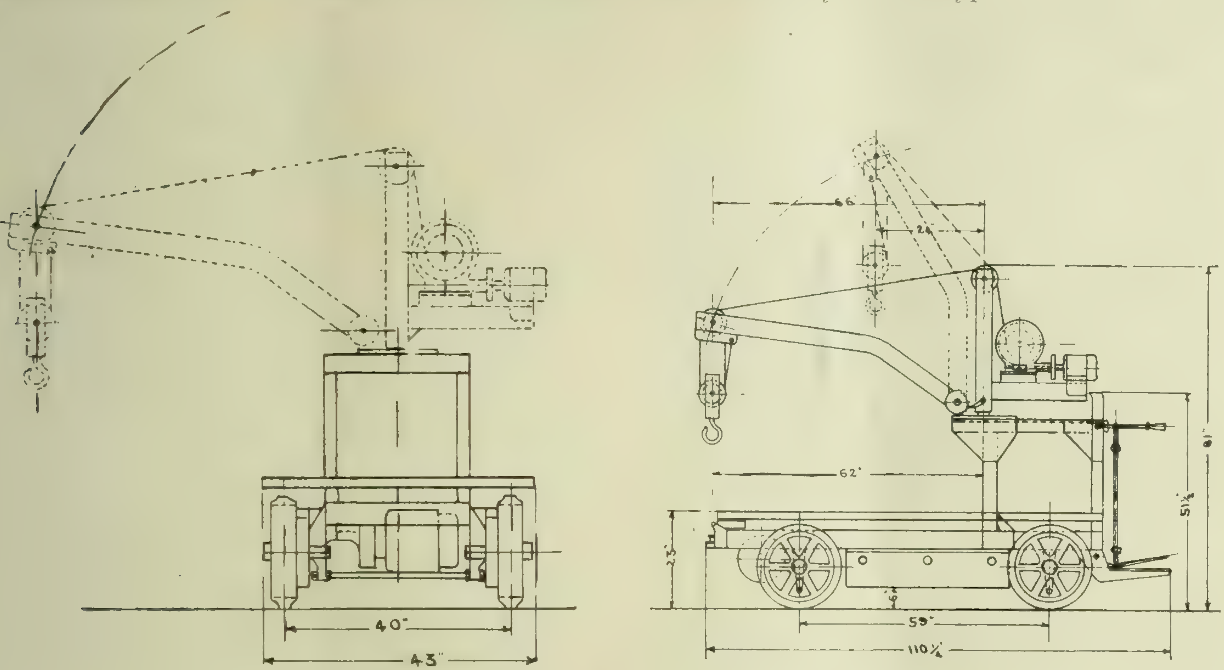

Fig. 4.

Fig. 5.—A Hunt Elevating Platform Truck.

crane of the particular truck illustrated has a lifting capacity of 1,500 lb., and has a maximum outreach of 66 in. Another very useful type of vehicle is the elevating platform truck, as shown in Fig. 5. In this case the articles to be carried are first loaded on a wooden skid raised a few inches from the ground, so that the truck platform, which can be raised and lowered by an independent electric motor, can pass underneath. The obvious advantage of a truck of this sort is that articles to be carried can be loaded on the skid whilst the truck is engaged elsewhere, and when it returns it can

Fig. 6.

pick up its load and transfer it to its proper destination without delay. There are also trucks with dump bodies for carrying loose materials, such as coal, and also electric tractors or locomotives. The firms supplying these locos. are: British Electric Vehicles, Ransomes, Sims & Jefferies, and Irwin & Jones, who also supply the "Hunt" trucks already described. One of the locos. made by British Electric Vehicles Ltd. is shown in Fig. 6, where the vehicle is shown drawing a number of trailers carrying castings unloaded from a railway truck. The loco. will haul a load of 10 tons on the level, or three tons up a gradient of 1 to 30, and the speed is about six miles per hour when hauling light loads, and five miles per hour when driving heavy loads. The controller gives three speeds, and is capable of dealing with the maximum starting current of 180 amperes without sustaining damage arising from arcing at the contacts. The motor is controlled on the series parallel system already described. Electric locos. of this sort are being used with great success in various kinds of industrial establishments, such as in iron and steel works, and there is no doubt whatever that in the near future they will be utilised on a very extensive scale.

Current Supply.

Coming now to the operation of electric trucks and tractors, it is, of course, essential to have access to a source of current supply in order to charge the batteries. Current can be drawn from any public supply system or from a private plant, but, in places where the supply is an alternating one, it is necessary to instal a converter. In any case, it is essential to reduce the supply pressure for the batteries belonging to electric trucks working at low pressure, such as 25 or 40 volts, and cannot therefore be connected directly to public supply mains. Sometimes the excessive pressure is absorbed in a resistance, but this practice is wasteful, especially when the supply pressure is 440 or 500 volts. If, however, a supply pressure of, say, 110 volts, is available, and the batteries of only one or two trucks have to be charged, the use of a resistance may be permissible. Suppose, by way of example, that the maximum charging pressure required is, say, 65 volts, and the charging current 30 amperes, and the supply pressure is 110 volts, then $110-65=45$ volts will have to be absorbed in the resistance, but if the supply pressure be 440, the pressure to be absorbed will be $440-65=375$ volts, and the watts wasted when charging with a current of 30 amperes would be $375\times30=11{,}250$ or 11·25 units per hour. Obviously then, it is very uneconomical to charge a number of trucks through resistances when the supply pressure greatly exceeds that of the battery, and a motor generator may very soon pay for itself, but the practice of charging through resistances is, nevertheless, sometimes permissible.

Special resistance units suitable for charging the batteries of electric trucks are made by the Igranic Electric Co., and one of these resistances is shown in Fig. 7. These regulating resistance units are mounted in metal frames forming switchboards, there being one regulator for each charging circuit to be controlled. Each unit, as shown in Fig. 7, consists of a slate base 24 in. long and 10 in. wide, and on the front of this base the regulating switch

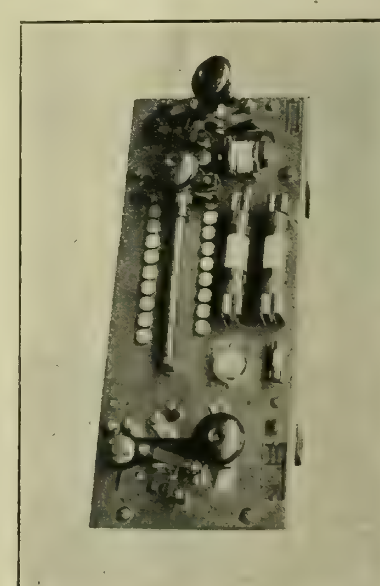

Fig. 7.

is mounted, together with an automatic cut-out, a meter-reading switch, and a pilot lamp, whilst at the back an iron grid resistance is fixed. The cut-out automatically disconnects the battery in the event of the supply pressure falling below the battery pressure, and this prevents the cells feeding back into the supply circuit. The cut-out is interlocked with the sliding crosshead of the regulating switch, so that the cut-out cannot be closed unless

the crosshead is moved to the position where all the resistance is inserted in the circuit. Under this condition the cut-out can be closed, and it is then held by a small electro-magnet in series with the main charging circuit. The meter-reading switch can be used either for interrupting the circuit or for connecting up a duplex ammeter and voltmeter, from which the battery current and voltage can be read, and a single meter serves for any number of regulating resistance units. These regulating resistances may also be used with advantage when electric truck batteries are charged from a motor generator, but in this case they only need absorb a few volts. Their function in this case is to enable the current flowing into any given battery to be regulated at will, according to the condition of the charge, and not to absorb the whole of the surplus pressure. It is obvious that if several batteries are charged from

Fig. 8.

a single motor generator any alteration of the main generated voltages will affect the current flowing into all the batteries, but if an adjustable resistance is connected in each charging circuit the current passing into any given battery can be regulated at will. Charging switchboards are also made by British Electric Vehicles Ltd., and one of these boards is shown in Fig. 8. On this board the following instruments, etc., are mounted: A voltmeter with a range of 0–40 volts, an ammeter with a range of 0–40 amperes, a 50-ampere cut-in and cut-out battery switch, suitable for a battery of 14 cells, a 50-ampere double-pole knife-switch, two 50-ampere removable fuses, and terminals for receiving the lugs of the charging cables. Space is also provided for a shunt regulator for controlling the voltage of the motor generator.

Suitable Accumulators.

At the present time two distinct types of accumulators are fitted to electric trucks—Ironclad Exide Accumulators (made by the Chloride Electrical Storage Co.), and Edison Accumulators (made by Edison Accumulators Ltd.). Both these accumulators are very satisfactory, and can be charged and discharged at high current rates. The Edison Co. naturally fits its trucks with its own accumulators, but other makers either fit Ironclad Exide accumulators exclusively or provide either type of battery according to purchaser's requirements. When Ironclad Exide cells are delivered in an uncharged condition, and without electrolyte in the cells, but with the corks in the vent holes, the cells should be filled with pure brimstone sulphuric acid having a specific gravity of 1,280, to a height one inch above the tops of the plates. The battery should then be allowed to stand for at least 12 hours, and if at the end of this time the level of the electrolyte is below that in the other cells, it may be concluded that one of the boxes has been broken in transit, and a new box should be substituted. The battery should then be put on charge at half the low or "finishing rate" marked on the name plate, and the charge should be continued until the voltage and specific gravity have remained stationary for at least five hours, the specific gravity of the electrolyte being measured, of course, by means of a hydrometer. This first charge must not be of less duration than 24 hours, irrespective of the readings, and of the electrolyte being maintained below 110 deg. Fah., if necessary by lowering the charging rate until the specific gravity of the acid and the voltage of one of the cells selected as the "pilot cell" attains a maximum and six-hourly readings show no increase. The standard temperature is 70 deg. Fah., and at this temperature the specific gravity of fully-charged cells should be between 1,275 and 1,258. On no account should the cells be discharged after the battery volts have dropped to 1·7 volts per cell.

After the battery has received its first charge, and has been discharged, the subsequent charges can be made in accordance with the constant current or constant potential methods. The former method is recommended when there is ample time to complete the charge. With Ironclad Exide batteries the charge is in this case commenced at the higher normal rate stamped on the name plate, and to obtain the current corresponding to this normal charging rate a voltage of about 2·15 to 2·2 volts per cell is necessary at the commencement, but as the charge proceeds it is necessary to increase the applied voltage in order to overcome the rising pressure of the cells, and when the voltage per cell reaches 2·3 the current should be allowed to taper off until it reaches the specified finishing rate. The voltage should then be adjusted from time to time in order to maintain this current constant until the pointer of an ampere hour meter set to register 10 or 15 per cent slow on charge takes up the zero position, when the charge can be discontinued.

Comparison of Charging Methods.

The constant potential method of charging differs from the constant current method in that during the time the current is being put into the

battery the equipment requires little attention. The charge is commenced, when Ironclad Exide cells are used, by applying a pressure to the battery equal to 2·3 volts per cell, and the charge proceeds with this voltage until the rise of the battery pressure reduces the current to the specified finishing rate, when the pressure may be increased to keep the current constant until the pointer of the ampere-hour meter takes up the zero position in the manner described. So-called "equalising charges" must also be given periodically in order to bring all the cells up to the same condition.

THE ANALYSIS OF GEAR VALVES.

By A. Houlson.

(*Continued from Vol. VII., page 382.*)

Fig. 6 shows the Joy radial gear. A is the crankpin; the connecting rod A, B is fitted with a pin at C, to which is attached a link C, D, E. This link is pinned at E to a lever E, F; the point E moves in an arc of radius F, E. At a point D of the link C, D, E a pin is fitted, to which is attached the link D, G, H. The point G is constrained to move in a curved slot K, K, and the point H is pinned to a radius rod H, J, which in turn is attached to the valve rod, and thus imparts motion to the valve.

To plot the motion of the valve, set out a number of equidistant points on the crankpin circle. With any one of these points as centre, and the length A, B of the connecting rod A, B as radius, mark off the positions of the crosshead pin centre. Join these points A and B by straight lines and mark off from B the distance B C, thus obtaining the elliptical path of C. Make a tracing of the link C, D, E. Place this tracing on Fig. 6, keeping the end C on the path of C, the end E on the arc of radius F, E, and prick through the tracing at D. This gives the path of D.

Next make a tracing of link D, G, H. Place the tracing on Fig. 6, keeping the end D on the path of D, the point G on the curved centre line of the slot K, K and prick through at the point H, thus obtaining the path of H. Now set the compasses to length H, J, and with one end of the compass on the path of H, mark off the corresponding points J on the centre line of valve. The travel x is the travel of the valve.

Notching up and reversing is effected by moving the curved slot K, K (which is pivoted on a trunnion whose centre coincides with the position G shown in Fig. 6) into another position such as that shown by dotted lines. When in mid-gear the curve K, K assumes a vertical position.

The motion of the valve, when plotted on the sine hart for various notches, gives curves very similar to those in Fig. 5.

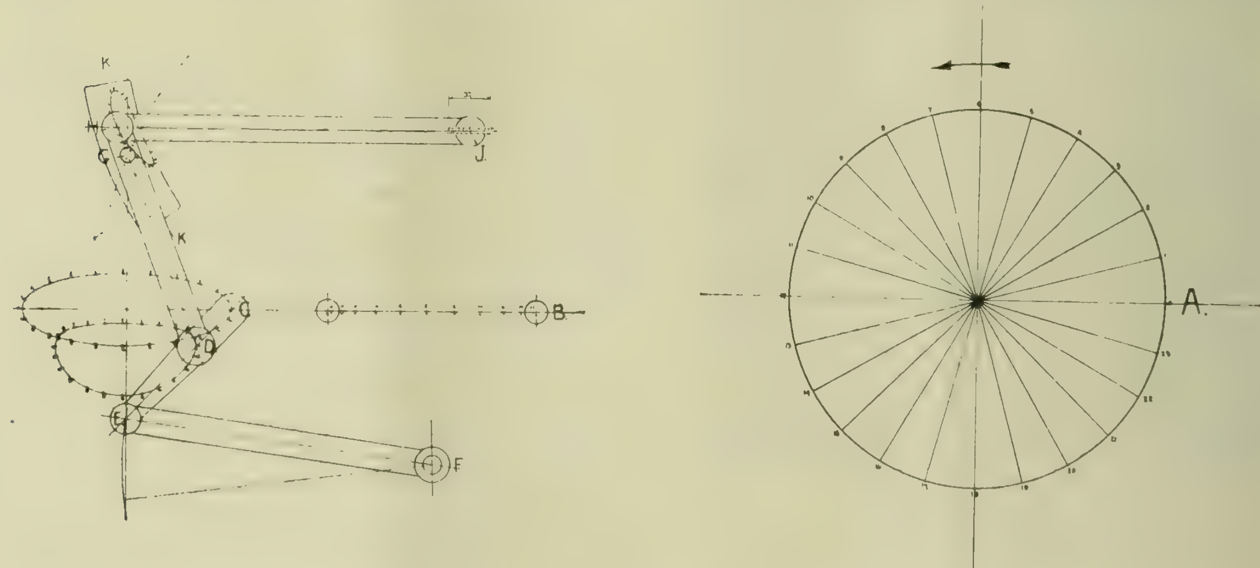

Fig. 6.

Switchboards.—A list containing prices and particulars of switchboards for all standard requirements has just been issued by the General Electric Co. Ltd., London. The illustrations are typical of the work which is continually passing through the G.E.C. Switchgear Works. The same firm have also issued a list giving descriptions and illustrations of their low, high, and extra high-tension switch gear.

Protecting Factory Workers: Guards for Power Presses.—The Government campaign of "Safety First" for all operatives of power-driven machinery will, we understand, shortly be enforced by the issue of new regulations in regard to power presses, insisting on an efficient guard to fence in the tools in addition to the protection derived from "hand levers." The description of a guard that will help to eliminate accidents in a machine shop consists of a toothed rack screwed to the ram of the press, operating a pinion wheel geared to a metal shutter, running on rods carried by two standards, and bolted to the ends of the bedplate of the press. The spindle being geared up, causes the lever arm to travel much faster than the ram, and the shutter sweeps across the work space with $\frac{3}{16}$ in. movement of the ram. A friction clutch is embodied in the movement, and the shutter remains stationary in front of the tools until the ram commences its upward movement, when the clutch again operates the lever, and the shutter is carried back to its original position, leaving the work space open for the feeding in of the next article, thus preventing any delay or slowing of output. The guard may be fitted to any standard power press by the drilling and tapping of six holes for $\frac{3}{8}$ in. or $\frac{1}{2}$ in. pins, and when once set, requires no adjustment if position of ram or stroke is altered.—*Works Management.*

THE ERA OF CHEAP POWER.

The era of cheap power has yet to come, and assuredly it will do so, notwithstanding the present price of coal. The latter may, in fact, provide just the stimulus required to awaken coal producers and coal consumers to the vital importance of dealing with the whole power problem on much broader lines than have yet been followed.

Coal is More than Fuel.

There are a few basic facts which cannot be over-emphasised. The first one is that coal is much more than a solid fuel. True, it is mostly a solid fuel, but the other constituents are at least of equal importance. Without embarking upon the details of chemical analysis, it may be said that a ton of coal will yield from 10 to 15 cwts. of solid fuel in the form of hard, gas-free coke or in the form of soft, smokeless fuel burning with a clear flame and suitable for domestic use. There may also be obtained from two to three gallons of motor spirit, from 10 to 15 gallons of various oils, from 70 to 100 lbs. of tar, and from 100 to 200 gallons of ammoniacal liquor. In addition, there are smaller quantities of by-products which constitute the raw materials of many "key" industries. The materials available vary in nature and quantity with the coal employed and with the temperature at which distillation is effected. Concerning these matters there is already available a mass of reliable experimental data, and it is one of the most curious features of the power problem that no large-scale permanent installations have yet been laid down to deal with coal in manners which numerous experimental installations have indicated as profitable.

Every Industry Concerned.

The main reasons why such trials had not already been conducted are probably conservatism of practice and considerations of capital expenditure. The events of recent years should surely have shattered conservatism in technology and have demonstrated that expenditure in this field is well invested. Fuel utilisation on a basis of all-round technical efficiency will undoubtedly involve great changes in practice and enormous capital expenditure, but both would necessarily be distributed over a period of years and over practically every industry in the country. It would not be a case of placing a burden upon every industry, but of offering to every industry a profitable investment or other equally tangible advantage. Full utilisation of coal offers to the colliery owner an outlet for all grades of coal, those too poor or too small for by-product treatment being capable of efficient utilisation in form of powdered or colloidal fuel. Powdered coal carried by a current of air forms practically a gaseous fuel, and if the powder be sufficiently fine, the particles can be suspended indefinitely in fuel oil in the colloidal state. In both cases very high thermal efficiency is attainable if the fuel be burned under proper conditions.

Turning to the consumer's point of view, general recovery of by-products from coal would contribute in an important degree to the available supplies of motor fuel. Agriculture would benefit from the increased supply of fertilisers, and the dye and general chemical industries would obtain large quantities of many valuable bases. The efficient resolution and utilisation of coal would accomplish automatically a *rapprochement* between electricity and gas undertakings to the benefit of both, and efficient utilisation of coal, by whatever process, necessarily involves elimination of smoke. In short, the proper utilisation of coal is of interest to us all, not merely from the altruistic standpoint of conserving our principal source of national wealth, but primarily because we are all concerned more or less directly with one or other of the coal-producing or consuming industries.

Lines of Advance.

Failure to deal sufficiently broadly with the fuel and power problem has hitherto been our chief sin of omission. Without incurring the perils of monopoly or the paralysis of bureaucracy, is it not practicable to draft a comprehensive scheme for the utilisation of all our natural sources of power on the two main principles: (1) That energy which is restored by nature (*e.g.*, water-power) be used in preference to irreplacable coal, even though the present cost be higher; and (2) that neither coal nor its by-products be wasted, either by neglecting to mine and utilise the poorer grades of fuel or by burning raw coal and sacrificing its by-products? It would be fatal to attempt sudden reorganisation or drastic interference with the intricate mechanism of power-producing and power-consuming industries, but it is not too much to ask that a scheme be drafted covering them all and aiming at maximum overall efficiency rather than maximum immediate efficiency in any particular branch or section of the whole. Let every fresh power development and every plant extension or replacement comply with such a scheme and our advance will be rapid and without dislocation.

Electricity and Gas Undertakings.

The time is past when the central station engineer should be allowed to burn raw coal simply because he is now able to do so and still compete with other power producers. Economy is a purely relative term, and the time is at hand when fuel shortage and the demand for power will compel the erection of generating and transmission schemes at costs far beyond the so-called economic limits hitherto accepted. Past follies cannot be undone, but it is imperative that the broader schemes be now adopted, even though they offer no immediate benefit to certain sections of the industries involved. Overall efficiency attained under a wise central control cannot fail to be to the ultimate benefit of all. Between them electricity and gas undertakings consume about 75 per cent of the industrial and domestic coal consumption of the country. The efficiency of the latest central stations is remarkable reckoned on the basis of burning coal for heat alone, but it must be admitted that the modern gasworks utilises coal more efficiently. Fusion of gas and electricity undertakings, as part of the scheme for "super-power stations" and national distribution networks, would be in the best interests of both industries, and would constitute a great advance in the direction of efficiency.

Utilising Exhaust Heat.

In addition to the improved utilisation of the material in coal, there is the equally important problem of improving the utilisation of its thermal content. Here again we have almost reached the

highest efficiency possible with existing basic practice, but year after year every steam engine is wasting in its exhaust or in its condenser 60 per cent of the heat in the steam supplied to it, and year after year coal is burned to supply warm water and low-temperature steam for innumerable industrial purposes. Is it not practicable to utilise most of the heat exhausted from engines for low-temperature industrial heating service? Obviously it is worth while to sacrifice efficiency in the prime mover itself, by adopting a higher exhaust temperature, if this makes possible utilisation of the greater part of the exhaust heat. It is along such broad lines of radical development that really cheap power service will be attained. The issues at stake justify the expenditure involved.—*Manchester Guardian.*

CAMS.

By W. E. Bennison, A.M.I.M.E.

(*Continued from Vol. VII., page 386.*

Miscellaneous Examples.

In order to give the student some idea of how cams are used, it is now proposed to illustrate just a few

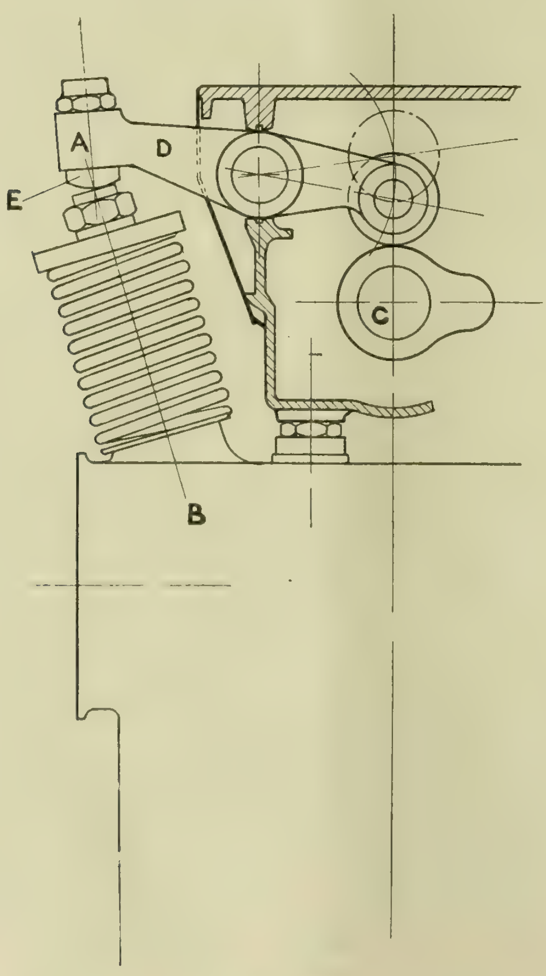

Fig. 72

examples of cam action. Of course, no attempt is made to describe the mechanisms of the machines of which the cams are parts. Such a thing would require elaborate drawings and is entirely outside the scope of these articles. Just sufficient of the mechanism has been shown to illustrate how the motion of the cam is transferred to the adjacent moving parts of the machine. These examples are all taken from actual practice and are typical cases.

Fig. 72 shows the valve mechanism of an aeroplane engine. The valve itself is not indicated, but the direction of its motion is along the line A B; it is held upwards against its seat by the spring.

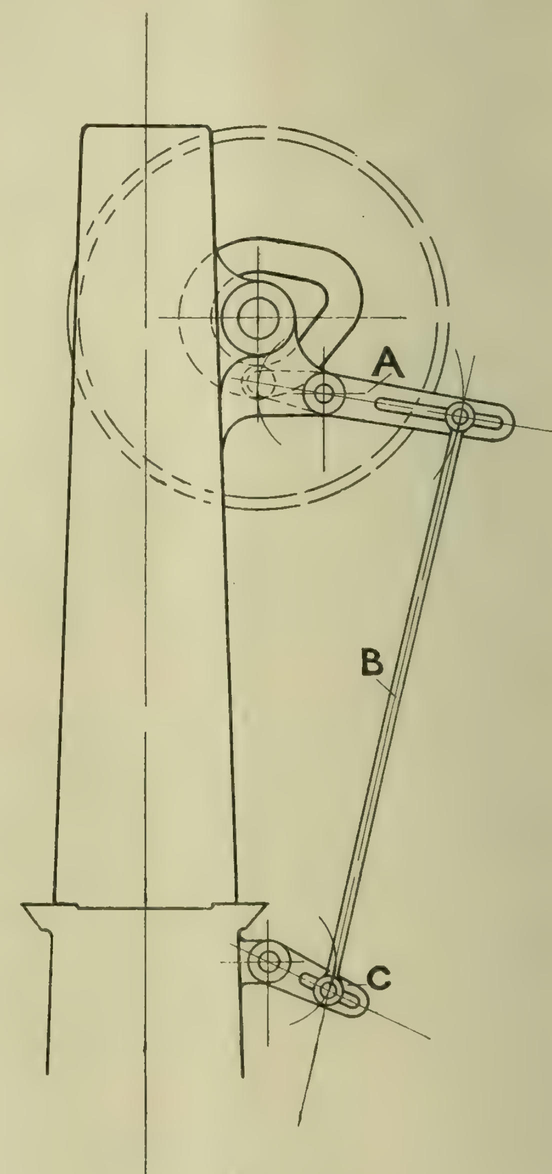

Fig. 73.

The cams and the camshaft C are usually made in one solid piece. The motion is transmitted through the lever D which, at the opposite end to the roller, carries the screw E. When the lever is rocked by the cam it is the rounded head of this screw E which presses on the end of the valve spindle and forces the value to drop. The valve is, of course, closed by the spring. Only one side of the cylinder is shown; the other side is exactly similar, but is symmetrical about the axis of the camshaft. The

inlet valves are all on one side, and the exhaust valves on the other side. For a six-cylinder unit there would be 12 cams on the one shaft.

Fig. 73 shows the feed motion of a slotting machine. The cam is usually fixed on to or is integral with the main spur gear of the machine. The motion is transmitted through the lever A by means of the connecting link B to the lower lever C. This lever drives the ratchet which turns the feed screw. Both levers are slotted so that, according to the position of the connecting link, the angular movement of C varies.

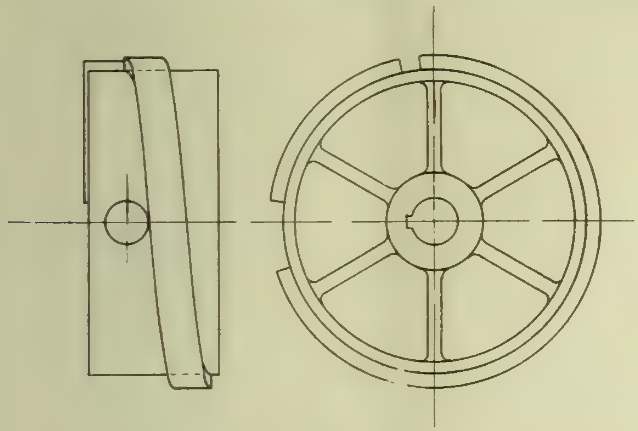

Fig. 74.

Fig. 74 is the main cam of the Gridley Automatic; that is the one which advances the main tool holder carrying the four tools. The cam is of the helical type. It consists of a drum with six arms keyed to the main shaft. Loose pieces of the required shape are fixed on to this drum by means of screws. The movement of the parts are quite simple and need no description beyond the indication of the position of the roller. The roller is carried by the tool holder itself, which slides backwards and forwards along a round guide parallel to the camshaft. The development of the cam is shown in Fig. 75. The direction of motion of the tool holder is at right angles to the development, and the direction of motion of the cam is indicated by the arrow. There are four loose pieces. The piece C moves the tool quickly up to the job, and then the slow advancement during the cutting is given by the long sloping piece D. B is simply a guard to prevent the tool running into the job after the quick movement. The return of the tool is made by the piece A. The total stroke of the tool is always the same, no matter what the length of the job. For a short job the piece C will be wider, B narrower, and the slope D less. For a long job C will be narrower, B wider, and the slope of D greater. For the same material and diameter the peripheral speed of the drum will change according to the slope of D in order to give the same rate of advancement. The piece A is never changed.

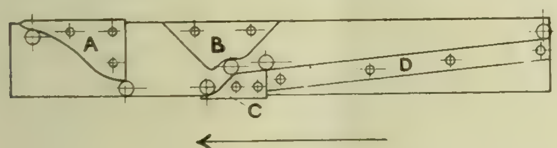

Fig. 75.

When A, B and C are in operation the machine is on the fast speed, and D on the slow speed.

Fig. 76 is a good example of a spiral cam with surface contact. It shows the feed-motion cam of a sewing machine, and is a cross section of the machine. The work is fed along by means of a small toothed plate, which pushes it away from the operator by a slight amount after every stitch. The toothed plate is not shown, but is reciprocated by means of the oscillation of the shaft A. Integral with A is the lever B. D is the camshaft. The cam actuates the forked lever E, causing it to oscillate about the point C, which is its point of attachment to B. The fork forms two surfaces, one on either side of the cam and with which the cam is always in contact. The cam is thus a double-acting one and will drive the lever in either direction. Attached to the lever E is a pin, upon which revolves F. G is a slotted disc (shown dotted behind the lever); it has a screwed stem, which passes through a hole in the sewing machine frame and serves to fix the disc to the frame. The disc can be fixed in any position relative to its axis, and therefore the inclination of the slot can be changed. In this slot the roller F operates. If the disc G is fixed in such a position that the slot is horizontal, the roller F will move backwards and forwards horizontally, and there will be no movement of the shaft A. If, however, the slot were to be fixed in an inclined position, as in the figure, a movement will take place, for if the lever moves to the right the roller will be forced upwards as it moves along the slot, and if moved to the left the roller will be forced downwards. The lever E will thus have a reciprocating motion in a

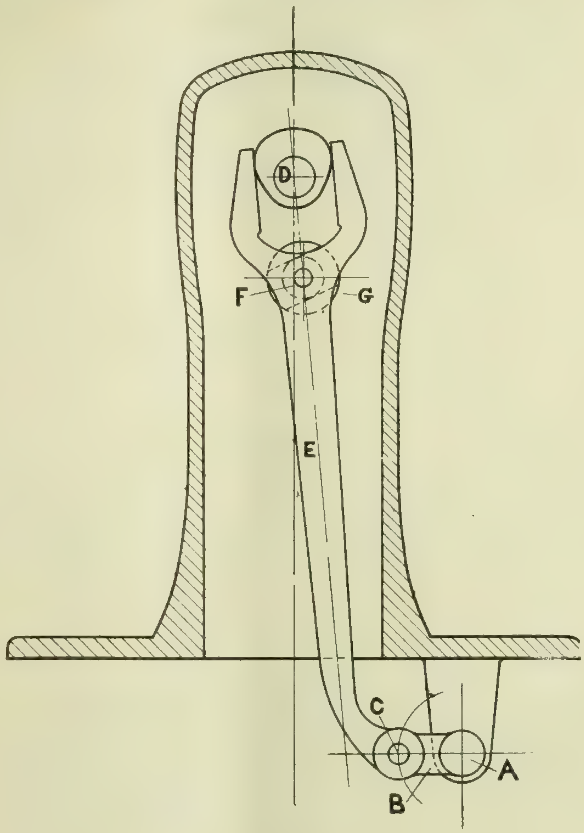

Fig. 76.

vertical direction as well as in a horizontal one. The result of these combined movements will be that the point C will rise and fall, and therefore cause the shaft A to oscillate. The amount of oscillation

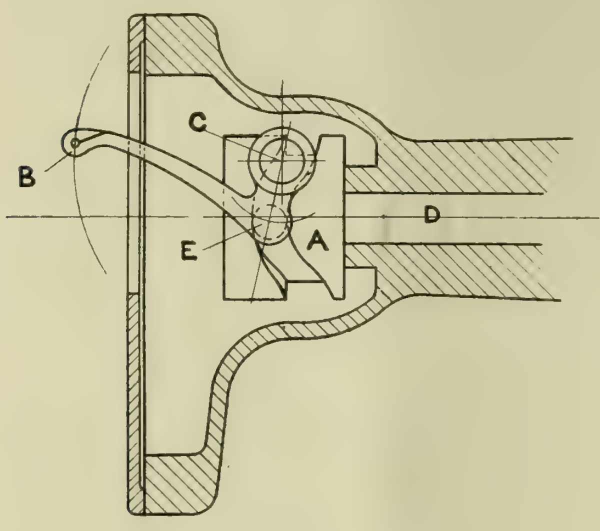

Fig. 77.

governs the travel of the toothed plate, and therefore the length of the stitch. The length of the stitch is thus regulated by the position of the slotted disc. To lengthen the stitch, the inclination must

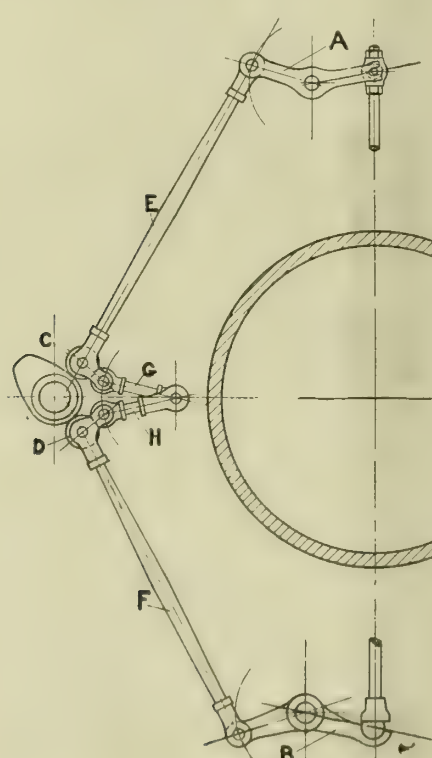

Fig 79.

be increased, and to shorten it the inclination decreased.

Fig. 77 is another example taken from the sewing machine, and is that of the take-up motion. The section is through the head of machine in which slides the needle bar (not shown). The camshaft D is the same one as the last illustration, and it carries the cam A. This cam is of the helical type, and is formed by cutting a groove of predetermined shape on the periphery of a cylinder. The peculiar-shaped take-up lever B is reciprocated by the cam. The lever is drawn in front of the cam and its fixing is therefore not shown, but it is fulcrumed at C, and E is the cam roller. The take-up lever has a small hole in its extremity through which passes the cotton on its way to the needle. The lever descends at the same time as the needle to allow the latter to pull down the cotton easily as it penetrates the material. When the needle has reached its lowest point the

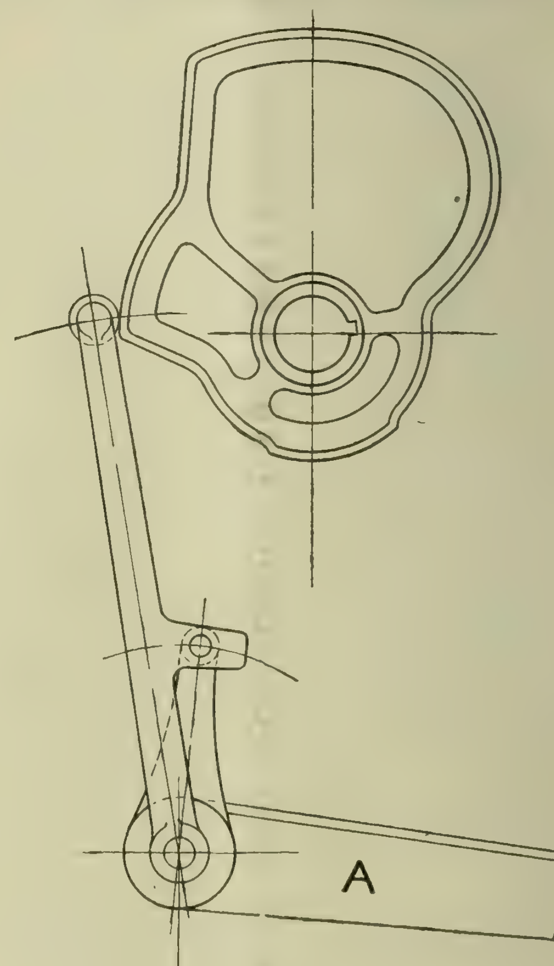

Fig. 78.

lever continues its descent at an increased rate of speed; this is to leave the cotton loose, so that the shuttle can pass through the loop. The lever next mounts rapidly, taking up the spare cotton, and then as the needle ascends it pulls the cotton taut to make a good firm stitch. All these motions have had to be taken into account in constructing the cam curve. A very interesting machine is the sewing machine from the standpoint of mechanical movements.

Fig. 78 is a good example of a spiral cam. It is chosen from the Linotype composing machine. No attempt is made to describe the mechanism, which is complicated. A certain part called the elevator has a vertical stroke. In certain positions

(*Continued on page 18.*)

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 89 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	7 3 22	0 15 3 16	1 3 3 10	1 11 3 4	1 19 2 26	2 7 2 20	2 15 2 14	3 3 2 8	3 11 2 2	0
1	0 3 5	8 2 27	0 16 2 21	1 4 2 15	1 12 2 9	2 0 2 3	2 8 1 25	2 16 1 19	3 4 1 13	3 12 1 7	1
2	1 2 10	9 2 4	0 17 1 26	1 5 1 20	1 13 1 14	2 1 1 8	2 9 1 2	2 17 0 24	3 5 0 18	3 13 0 12	2
3	2 1 15	10 1 9	0 18 1 3	1 6 0 25	1 14 0 19	2 2 0 13	2 10 0 7	2 18 0 1	3 5 3 23	3 13 3 17	3
4	3 0 20	11 0 14	0 19 0 8	1 7 0 2	1 14 3 24	2 2 3 18	2 10 3 12	2 18 3 6	3 6 3 0	3 14 2 22	4
5	3 3 25	11 3 19	0 19 3 13	1 7 3 7	1 15 3 1	2 3 2 23	2 11 2 17	2 19 2 11	3 7 2 5	3 15 1 27	5
6	4 3 2	12 2 24	1 0 2 18	1 8 2 12	1 16 2 6	2 4 2 0	2 12 1 22	3 0 1 16	3 8 1 10	3 16 1 4	6
7	5 2 7	13 2 1	1 1 1 23	1 9 1 17	1 17 1 11	2 5 1 5	2 13 0 27	3 1 0 21	3 9 0 15	3 17 0 9	7
8	6 1 12	14 1 6	1 2 1 0	1 10 0 22	1 18 0 16	2 6 0 10	2 14 0 4	3 1 3 26	3 9 3 20	3 17 3 14	8
9	7 0 17	15 0 11	1 3 0 5	1 10 3 27	1 18 3 21	2 6 3 15	2 14 3 9	3 2 3 3	3 10 2 25	3 18 2 19	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q lbs.	Weight.
	7·42	14·84	22·26	1 1·68	1 9·10	1 16·52	1 23·94	2 3·36	2 10·78	2 18·20	2 25·62	3 5	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 89 lbs. per foot.

[ALL RIGHTS RESERVED.]

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	3 19 1 24	7 18 3 20	11 18 1 16	15 17 3 12	19 17 1 8	23 16 3 4	27 16 1 0	31 15 2 24	35 15 0 20	0
10	0 7 3 22	4 7 1 18	8 6 3 14	12 6 1 10	16 5 3 6	20 5 1 2	24 4 2 26	28 4 0 22	32 3 2 18	36 3 0 14	10
20	0 15 3 16	4 15 1 12	8 14 3 8	12 14 1 4	16 13 3 0	20 13 0 24	24 12 2 20	28 12 0 16	32 11 2 12	36 11 0 8	20
30	1 3 3 10	5 3 1 6	9 2 3 2	13 2 0 26	17 1 2 22	21 1 0 18	25 0 2 14	29 0 0 10	32 19 2 6	36 19 0 2	30
40	1 11 3 4	5 11 1 0	9 10 2 24	13 10 0 20	17 9 2 16	21 9 0 12	25 8 2 8	29 8 0 4	33 7 2 0	37 6 3 24	40
50	1 19 2 26	5 19 0 22	9 18 2 18	13 18 0 14	17 17 2 10	21 17 0 6	25 16 2 2	29 15 3 26	33 15 1 22	37 14 3 18	50
60	2 7 2 20	6 7 0 16	10 6 2 12	14 6 0 8	18 5 2 4	22 5 0 0	26 4 1 24	30 3 3 20	34 3 1 16	38 2 3 12	60
70	2 15 2 14	6 15 0 10	10 14 2 6	14 14 0 2	18 13 1 26	22 12 3 22	26 12 1 18	30 11 3 14	34 11 1 10	38 10 3 6	70
80	3 3 2 8	7 3 0 4	11 2 2 0	15 1 3 24	19 1 1 20	23 0 3 16	27 0 1 12	30 19 3 8	34 19 1 4	38 18 3 0	80
90	3 11 2 2	7 10 3 26	11 10 1 22	15 9 3 18	19 9 1 14	23 8 3 10	27 8 1 6	31 7 3 2	35 7 0 26	39 6 2 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	39 14 2 16	79 9 1 4	119 3 3 20	158 18 2 8	198 13 0 24	238 7 3 12	278 2 2 0	317 17 0 16	357 11 3 4	397 6 1 20	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 90 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 0 4	0 16 0 8	1 4 0 12	1 12 0 16	2 0 0 20	2 8 0 24	2 16 1 0	3 4 1 4	3 12 1 8	0
1	0 3 6	8 3 10	0 16 3 14	1 4 3 18	1 12 3 22	2 0 3 26	2 9 0 2	2 17 0 6	3 5 0 10	3 13 0 14	1
2	1 2 12	9 2 16	0 17 2 20	1 5 2 24	1 13 3 0	2 1 3 4	2 9 3 8	2 17 3 12	3 5 3 16	3 13 3 20	2
3	2 1 18	10 1 22	0 18 1 26	1 6 2 2	1 14 2 6	2 2 2 10	2 10 2 14	2 18 2 18	3 6 2 22	3 14 2 26	3
4	3 0 24	11 1 0	0 19 1 4	1 7 1 8	1 15 1 12	2 3 1 16	2 11 1 20	2 19 1 24	3 7 2 0	3 15 2 4	4
5	4 0 2	12 0 6	1 0 0 10	1 8 0 14	1 16 0 18	2 4 0 22	2 12 0 26	3 0 1 2	3 8 1 6	3 16 1 10	5
6	4 3 8	12 3 12	1 0 3 16	1 8 3 20	1 16 3 24	2 5 0 0	2 13 0 4	3 1 0 8	3 9 0 12	3 17 0 16	6
7	5 2 14	13 2 18	1 1 2 22	1 9 2 26	1 17 3 2	2 5 3 6	2 13 3 10	3 1 3 14	3 9 3 18	3 17 3 22	7
8	6 1 20	14 1 24	1 2 2 0	1 10 2 4	1 18 2 8	2 6 2 12	2 14 2 16	3 2 2 20	3 10 2 24	3 18 3 0	8
9	7 0 26	15 1 2	1 3 1 6	1 11 1 10	1 19 1 14	2 7 1 18	2 15 1 22	3 3 1 26	3 11 2 2	3 19 2 6	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	
Weight.	7·5	15	22·5	1 2	1 9·5	1 17	1 24·5	2 4	2 11·5	2 19	2 26·5	3 6	Weight.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 90 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 0 1 12	8 0 2 24	12 1 0 8	16 1 1 20	20 1 3 4	24 2 0 16	28 2 2 0	32 2 3 12	36 3 0 24	0
10	0 8 0 4	4 8 1 16	8 8 3 0	12 9 0 12	16 9 1 24	20 9 3 8	24 10 0 20	28 10 2 4	32 10 3 16	36 11 1 0	10
20	0 16 0 8	4 16 1 20	8 16 3 4	12 17 0 16	16 17 2 0	20 17 3 12	24 18 0 24	28 18 2 8	32 18 3 20	36 19 1 4	20
30	1 4 0 12	5 4 1 24	9 4 3 8	13 5 0 20	17 5 2 4	21 5 3 16	25 6 1 0	29 6 2 12	33 6 3 24	37 7 1 8	30
40	1 12 0 16	5 12 2 0	9 12 3 12	13 13 0 24	17 13 2 8	21 13 3 20	25 14 1 4	29 14 2 16	33 15 0 0	37 15 1 12	40
50	2 0 0 20	6 0 2 4	10 0 3 16	14 1 1 0	18 1 2 12	22 1 3 24	26 2 1 8	30 2 2 20	34 3 0 4	38 3 1 16	50
60	2 8 0 24	6 8 2 8	10 8 3 20	14 9 1 4	18 9 2 16	22 10 0 0	26 10 1 12	30 10 2 24	34 11 0 8	38 11 1 20	60
70	2 16 1 0	6 16 2 12	10 16 3 24	14 17 1 8	18 17 2 20	22 18 0 4	26 18 1 16	30 18 3 0	34 19 0 12	38 19 1 24	70
80	3 4 1 4	7 4 2 16	11 5 0 0	15 5 1 12	19 5 2 24	23 6 0 8	27 6 1 20	31 6 3 4	35 7 0 16	39 7 2 0	80
90	3 12 1 8	7 12 2 20	11 13 0 4	15 13 1 16	19 13 3 0	23 14 0 12	27 14 1 24	31 14 3 8	35 15 0 20	39 15 2 4	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	
Weight.	40 3 2 8	80 7 0 16	120 10 2 24	160 14 1 4	200 17 3 12	241 1 1 20	281 5 0 0	321 8 2 8	361 12 0 16	401 15 2 24	Weight.

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it is necessary for it to remain stationary to permit of other operations. The movement of the elevator is caused by the oscillation of the lever A, and the cam has several "dwells" to give the stationary periods. The roller is kept pressed against the cam by means of a spring. The cam is very lightly built, there being no waste metal, but it is well up to its work.

Fig. 79 shows the valve mechanism of a large gas engine. The inlet valve is at the top and the exhaust valve at the bottom of the cylinder. Only the extremities of the valve spindles are shown. The valves are kept tightly pressed against their seatings by means of powerful springs. The opening of the valves is performed by the cam rocking the levers A and B. The closing is done by the springs, the cam merely regulating the time and the velocity of the closing. The cam rollers C and D are carried by the connecting rods E and F. These connecting rods are pivoted to the links G and H, which are again pivoted to a support fixed to the jacket of the cylinder.

INERTIA TORQUE IN CRANKSHAFTS.

(*Continued from Vol. VII., page 397.*)

FIG. 7 shows the same values when $W R = 1$—that is to say, for various conditions of constant displacement on the assumption that the weight of parts per

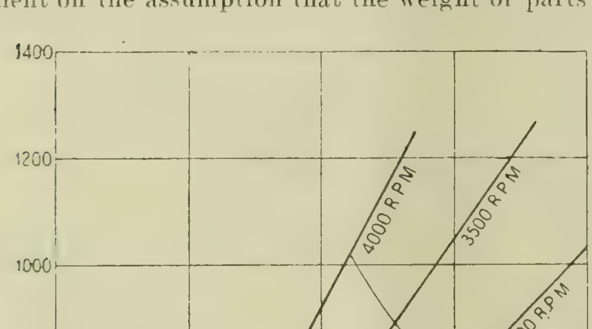


FIG. 7.—Values of $R.\omega^2/12.g.$

square inch of piston area is constant. Actually this should decrease slightly with the bore, and therefore this particular figure does not show sufficient favour to the engine of high stroke/bore ratio. In this case it will be seen that the lines for piston speed fall to the right—that is to say, for a given displacement and piston speed, the longer the stroke the less the inertia torque—actually, it varies as $1/R$—*i.e.*, it is in inverse ratio to the stroke. In connection with these two charts, it should be noted that in the first case at any fixed piston speed the inertia force, and therefore the side pressure on the cylinder wall, varies directly as the revolutions per minute—*i.e.*, inversely as the stroke, while in the second case these values are constant for any given speed of revolution regardless of the stroke.

Balance Weights.

At an earlier stage it was stated that, since the velocity of rotation of balance weights is uniform, they can have no influence whatever on the inertia torque. With a zero coefficient of speed variation this is perfectly true, but unfortunately a zero coefficient requires an infinite flywheel. In actual practice the effective flywheel consists of the flywheel plus the crankshaft, the big ends and balance weight complete. Now consider the case of a single-cylinder engine, and take three examples: (*a*) With inside flywheels only (ordinary motor-cycle practice) of which the angular momentum is represented by unity; (*b*) with inside and outside flywheels, each having an angular momentum represented by 0·5; and (*c*) with an outside flywheel only, of which the angular momentum is again unity, the angular momentum of the crankshaft in this case being assumed to be zero. Then it is fairly obvious that the coefficient of speed variation is the same in each case, while the relative inertia torque in the main journal is represented by zero in case (*a*), 0·5 in case (*b*), and unity in case (*c*). In the general case we may take it as true that if $W_1R_1^2\omega^2$ be the angular momentum of the inside flywheel and crankshaft, and $W_2R_2^2\omega^2$ that of the outside flywheel, the ratio of the inertia torque transmitted through the journal to that in the case of the outside flywheel only of equal total angular momentum is $W_2R_2^2/(W_1R_1^2 + W_2R_2^2)$; in other words, the greater the value of $W_1R_1^2$ in relation to $W_2R_2^2$, the less the stress in the journals. Now crank cheeks and balance weights act as internal flywheels, and therefore do their share towards reducing the stress in the journals and so in turn towards reducing the angular distortion of the crankshaft.

In a multi-cylinder engine the effect is still greater, since the whole of the inertia torque being transmitted from each crank pin to or from the flywheel, part also may be taken by the journals further from the wheel, thus tending still further to reduce the stress and to more equal distribution of stress throughout the length of the crankshaft. This reduction of stress will have a very big influence on the angular distortion of the shaft, for just as the inertia torque has been shown to be cumulative towards the flywheel, so the angular distortion is cumulative away from the flywheel. The author is inclined to think that much of the success of Mr. Lanchester's vibration damper is due to the facts pointed out in the foregoing paragraphs rather than to any particular merits of the damping effect owing to the clutch.

It has always been the author's practice to err distinctly on the heavy side in designing a crankshaft, even to a point which some might consider absurd,

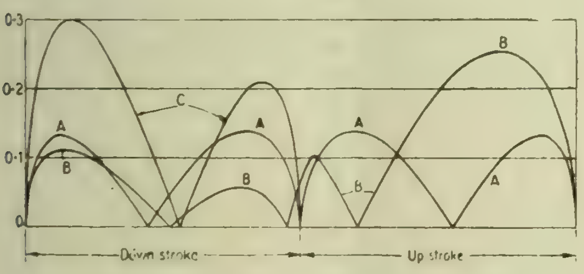
and to distribute the weight so as to obtain the maximum flywheel effect, and he has always found it profitable, so far as the running of the engine is concerned. One particular engine would run up to 3,400 revolutions per minute without any signs of a critical speed. He was once persuaded to cut a crankshaft down in order to reduce manufacturing costs on a small high-speed engine, with disastrous results.

Before leaving this subject of balance weights, the author would like to point out, as has already been done by others, that in a multi-cylinder engine of which the crankshaft is of what Mr. Lanchester has called "looking-glass symmetry," their effect is absolutely nil, so far as linear balance is concerned. They most certainly relieve main bearing pressures, thus adding to the life of an engine, and they will often save a weak crankshaft or whippy crank case for the same reason. More than one series of crankshaft failures has been cured by the addition of balance weights, but the author is very much inclined to think that in these cases the cure has been largely due to the distribution of flywheel effect.

It should also be pointed out that, although the flywheel effect of the balance weights, etc., may reduce the inertia torque in each individual journal, it has no effect whatever on the resultant reaction for which the values given for the last journal always hold good.

Side Pressures.

While preparing the various curves shown in this paper, the author thought that it might be interesting to plot the side pressures on the cylinder wall



A—Central. B—Désaxe R/4. C - Rotary. A and C repeat symmetrically about the centre line B.

Fig. 8.—Showing coefficients for side pressures.

due to inertia; these are shown in Fig. 8 for (*a*) the ordinary central engine, (*b*) the desaxé engine, offset R/4, and (*c*) the rotary engine, all with a four to one connecting rod ratio. The curves are shown all on the one side of the zero line since they always represent negative work, although actually they change about from side to side of the cylinder walls. The factor to determine the actual values of the pressure is in every case $WR\omega^2/12g$ and for negative work done $2WR^2\omega^2/12g$ / mean height $\times$ coefficient of friction. The ratios of the total areas included between the curves and the zero line represent the relative losses due to piston friction in the various types. It will be seen that although at low speeds the desaxé engine is undoubtedly more efficient than the central type owing to the relatively small angularity of the connecting rod on the explosion stroke, yet at high speeds, when the inertia forces approach the explosion pressure, the losses on the upstroke due to the greater angularity may easily counterbalance this. The author is convinced from his own experience that at really high speeds the central engine is the more efficient, though, of course, it is impossible to state this as a definite fact without actually making an engine in which the cylinders can be moved over without disturbing anything else.

Conclusion.

It may be argued that an engine is not run at really high speeds except under load, and that then the explosion pressure flattens the curve at the commencement of the stroke. This, however, is only true to a very limited extent. The following facts must be borne in mind: (1) That full-throttle high-speed bursts are of comparatively short duration in this country, and that they are usually followed by an abrupt closing of the throttle when the conditions shown in the figures are set up; (2) that the greater part of the high-speed running is done under favourable conditions or climbing on low gears, only requiring partial throttle opening; (3) that it is under no load or light load conditions that an engine generally shows up its worst points, and that just as many crankshaft failures occur under these conditions as under heavy load; and (4) that even under full load the curves hold good for three out of the four strokes in every journal except the last.

Actually, it was a case of crankshaft failure in a horizontally opposed two-throw crank engine which first induced the author to investigate this subject. The engine concerned was rather a freak in certain respects, and the reciprocating parts were unduly heavy in proportion to the piston area and explosion pressure, so that the conditions were very similar to those obtaining in an ordinary engine at partial throttle opening. The main journal on the flywheel side was carried on two ball bearings, a large one close to the crank web and a smaller one near the flywheel. While running at a speed in the neighbourhood of 3,000 revolutions per minute, the shaft twisted off between the two bearings. Investigation on the lines of this paper showed that the maximum stress due to inertia torque was 22 tons per square inch, with a periodicity of 12,000 alternations per minute from a positive maximum to a negative maximum. Being a mild nickel chromium shaft of about 50 tons ultimate strength failure was not surprising.

In order further to show the very real effects of this inertia torque even under load conditions, curves are included for the first and last journals of a four-cylinder engine under combined inertia and explosion torque, the explosion curve being calculated on the basis $PV^{1\cdot3}$ = constant, and with a 5 to 1 compression ratio. See Figs. 9A and 9B.

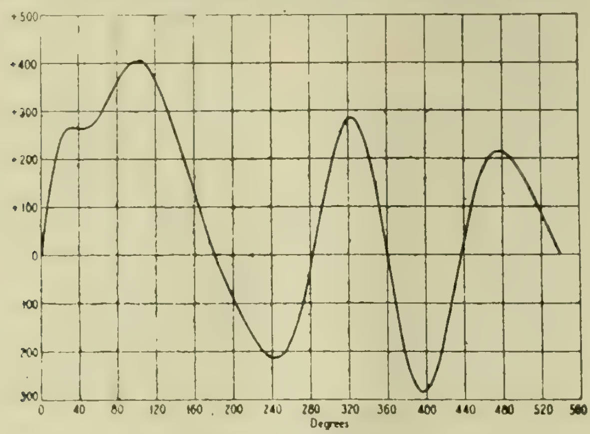
The following is a brief résumé of the points which the author wishes to emphasise in this paper:—

(1) Inertia sets up a serious alternating torsion stress in the crankshaft journals, in addition to the loads usually recognised, the frequency of which in a static engine is never less than four times the speed of revolution, and this stress is only slightly modified by the explosion pressure.

(2) Bearing (1) in mind, the essentials for a crankshaft steel are seen to be high fatigue range and resist-

ance to attrition, coupled with a high stress/strain ratio, rather than high ultimate strength. (The author believes from one experiment which he tried that this ratio is comparatively low in the high nickel chromium steels, but is open to conviction.)

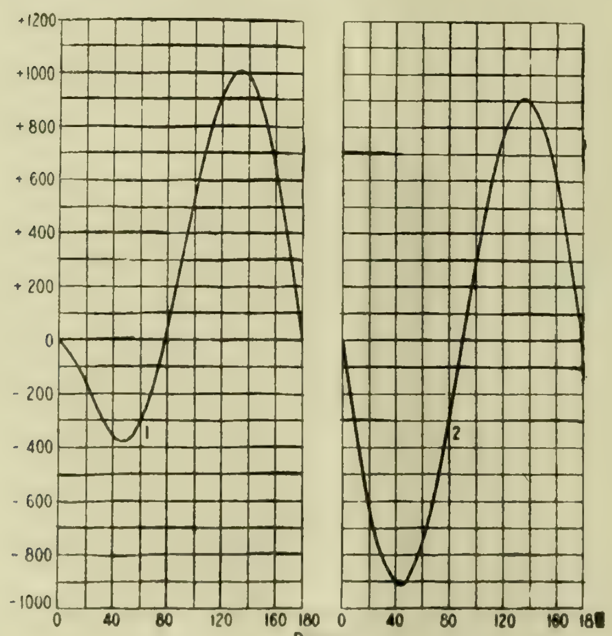
(3) The types of engine having only one line of parts to each crank pin, are the worst in respect to



Journal 1, Engine No. 19.

Nett torque in lb.-in. per sq. in piston area at maximum revs. per minute. Peak explosion pressure being 500 lb. per sq. in. (Curve shows $1\frac{1}{2}$ revolutions.)

Fig. 9a.



Nett torque in lb.-in. per sq. in. piston area at maximum revs. per minute. Peak explosion pressure being 500 lb. per sq. in.

Inertia torque in lb.-in. per sq. in. piston area at maximum revs. per min.

Engine No. 19, Table C.

Curve 1.—Explosion and inertia; Journal 4.
Curve 2.—Inertia; Journal 4.

Fig. 9b.

this inertia torque, while the multi-cylinder radial engines are the best.

(4) Of the twin arrangements, the 90 deg. Vee type is the best and the flat twin the worst, coming as it really does under the heading in the first sentence of (3).

(5) Of the triple arrangements, the Broad Arrow type of 60 deg. aside is superior to the three-cylinder radial engine, and it is certainly more convenient.

(6) The length of the connecting rod has very little effect on this torque, though it has on other things.

(7) Balance weights and any internal flywheel effect reduce and equalise the crankshaft stress very

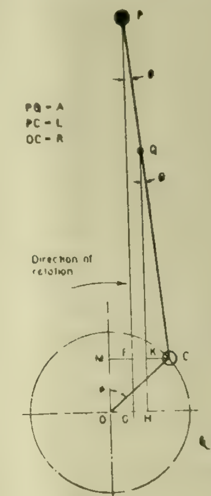


Fig. 10.

considerably, but have absolutely no effect on the resultant reaction.

Of course, it must be understood that it is not intended to assert that this question of inertia toque is the most vital one, but only that it is one to which serious thought should be given when considering what type of engine to adopt, especially now that so many designers are breaking away from the conventional four and six-cylinder types, and that it is a point to which thought should be given in the design of any type of crankshaft. No single consideration can be absolutely final in determining the "best

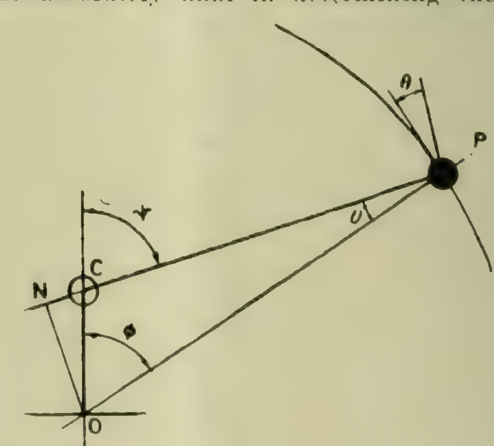


Fig. 11.

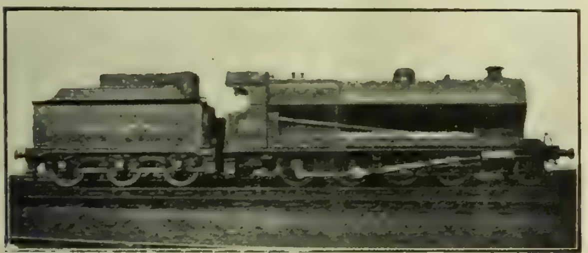
engine"; were it so, there would be one type and one only in existence, and the author certainly would not like to hazard a guess as to what that type would be; but each single point has to be given its relative value according to the mentality of the designer or the directors—more often the latter—and fortunately for us all the old saying is still as true as ever: *de gustibus non disputandum.*

(*Concluded.*)

LOCOMOTIVE FUEL TESTS ON THE GREAT CENTRAL RAILWAY.

The importance of the "fuel problem" in connection with locomotives on railways is very great, and provides one of the limiting bases when computing the probable life and future activities of the steam locomotive. It is possible without resorting to alternative forms of fraction to improve the present style of the locomotive, and thus raise its efficiency, by experimenting and altering the arrangements in vogue for the combustion of the fuel. This involves the reconstruction of the firebox and the adoption of new means of transferring the fuel to the point of combustion. There is no insuperable difficulty about this, and the main difficulty would appear to be, with regard to certain masses of fuel, that which is concerned with supplies of the requisite material.

Fuel for locomotive purposes may be divided into several kinds and qualities. It is possible to burn, in addition to ordinary steam-raising coal in lump form, finely divided or pulverised coal, and a colloidal mixture, consisting of pulverised coal and oil. These may be termed the more usual or generally recognised grades, although, as was shown during the war, it is possible to raise steam in locomotive boilers by burning other kinds of fuel.



2-8-0 Type Locomotive (No. 420), Great Central Railway, fitted with Apparatus for burning Colloidal Fuel.

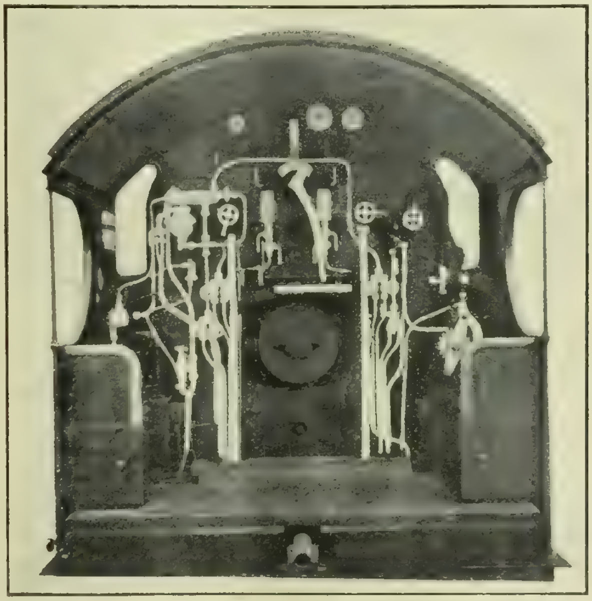
Nearer home, we have the example of the Great Eastern Railway, on which a former locomotive superintendent, Mr. James Holden, converted and built a number of engines for burning oil fuel. This practice spread in a lesser degree to some other railways in this country, including the South Eastern and Chatham, London, Brighton and South Coast and Lancashire and Yorkshire Railways, whilst at the present time, other railways are contemplating reviving the practice, an engine having already been converted for one of the leading main lines to this system.

On the Great Central Railway matters have been carried further still, and a series of comparative tests have been run with engines equipped—(1) for ordinary coal burning; (2) colloidal mixture, and (3) pulverised fuel. We are indebted to the courtesy of Mr. J. G. Robinson, the company's chief mechanical engineer, for photographs and drawings of the engine equipped for burning a colloidal mixture consisting of 60 per cent of pulverised coal and 40 per cent of oil; and a profile map of the sections of line worked over. This provides some very interesting matter for reflection on the part of those who study the subject of the locomotive on the basis of fuel consumption and steam production.

The engines tested were Nos. 419, 320 and 422. They are of the 2-8-0 type, with 21 in. by 26 in. cylinders and 4 ft. 8 in. diam. coupled wheels. The boiler barrel is 15 ft. long and 5 ft. 6 in. diam. outside at the firebox end. "Robinson" superheating apparatus is fitted, and as designed for coal burning in the ordinary way a total heating surface, including the superheater, of 2,123 sq. ft. is afforded. The grate area is 26 sq. ft. and the working pressure 180 lb. per square inch. The engine develops a tractive force of 34,237 lb. at 85 per cent of the boiler pressure, and with the standard tender weighs 123·5 tons, with 67 tons 18 cwt. of adhesion weight.

The section of line worked over is that which extends from near Gorton, a mile or two from the London Road terminal station of the Great Central Railway, Manchester, to Dunford, immediately east of the Woodhead Tunnel. As the profile diagram on page 22 shows, this section constitutes a practically continuous gradient, many portions of which are of considerable steepness. The actual tests began at Dewsnap Sidings on an up grade of 1 in 77, and subsequently the engines had to face grades of 1 in 86, 1 in 97, 1 in 100 and 1 in 117, with intervening lengths of, for example, 1 in 153, and 1 in 143 and 1 in 122, etc., a total rise of about 700 ft. being reached in a distance of about 17¾ miles. The pull is thus a very severe one, requiring an output from the locomotive of a high character, probably in the neighbourhood of 1,100 H.P. or more.

The trains were made up, as shown, of 80 empty

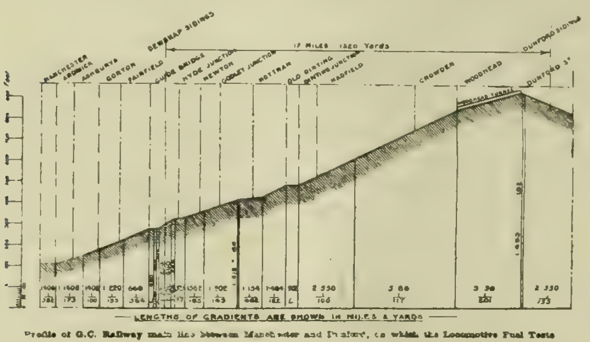


Interior of Cab, No. 420 Locomotive, Great Central Railway.

wagons and one brake van in the case of engines Nos. 419 and 420, and 79 empties and one brake van for engine 422. In spite of the smaller number of vehicles in the east case the weight of the train was slightly heavier, whilst the tender of engine No. 422, with its fuel, weighed nearly 9 tons more than that of engine No. 419 and, roughly speaking, 3½ tons more than the tender of engine No. 420 carrying the colloidal mixed fuel. The gross weights of the trains, as the figures show, varied similarly, engine No. 419 with ordinary

coal having the lightest total load, and 422 the heaviest, the difference beween No. 420's train and that of No. 422 being relatively light.

The trial proper commenced as stated at Dewsnap Sidings, a mile or two east of Gorton, and extended for a distance of 17 miles 1,320 yds., terminating on the falling grade of 1 in 135 after Woodhead Tunnel, where Dunford Sidings are reached. Engine No. 419 with ordinary grate completed the distance in



Profile of the Grent Central Railway main line between Manchester and Dunford, on which the Locomotive Fuel Tests were made.

1 hour 23 minutes, No. 420 with colloidal mixture in 1 hour 14 minutes and No. 422, burning pulverised fuel, in 1 hour 29 minutes. The reason for No. 422 taking a longer time than the others was that the speed was slackened for a considerable distance by signals, for permanent way purposes. Thus, the locomotive with mixed fuel completed its journey in the shortest time. It is noticeable that the average superheat was higher in the case of the colloidal fuel locomotive than in either of the others, and there are other indications, as gathered from the table, which would tend to show that this engine exhibited a certain amount of superiority over the others in the handling of its train.

We certainly think Mr. Robinson is to be congratulated on the enterprise he has shown in carrying out these tests.—*The Railway Gazette*.

Motor Transport in India. Since April, 1915, when the Government of India first decided to possess its own mechanical transport, the number of personnel and vehicles have increased with every year, till at the end of 1919 there were something like 5,000 personnel, and about 4,000 mechanical transport vehicles under its administration, including the Ford vans and cars specially obtained for the Afghan war, and now in use on the frontier. The use of mechanical vehicles among the commercial community is also largely increasing, and in Bombay, Calcutta and other commercial centres, a large amount of goods is being conveyed by mechanical transport, which till a few years ago was moved solely by animal power. There has also been a great increase in the number of motor cars used by both the British and Indian community. Purely European types, both of lorries and of ordinary motor cars, are unsuitable for use in India during a considerable portion of the year owing to their having insufficiently large radiators. It is true that some European types continue to run, but they are operated at a disadvantage compared with those that have been specially designed to suit tropical conditions. When the water in the radiator is constantly boiling, not only is there a serious decrease in power produced by the engine, but mechanical troubles tend to develop as the direct result of overheating. In my opinion, there is a great future before any firm who cares to specialise in a tropical model for the private owner's car. As regards lorries, the Indian Standard 2½ ton vehicle specially designed for tropical use, has already proved its worth, and is probably the best lorry for work in hot climates that has yet been designed.—*Journal of the Royal Society of Arts*.

THE ENGLISH ELECTRIC WORKS.

The Phœnix works of the English Electric Co. were established 20 years ago by the Phœnix Dynomo Manufacturing Co. Ltd. They cover a large area and are fortunate in having room for expansion. At the present time, well over 1,000 people are employed. The present company, which also controls Dick Kerr

Small and Medium Machine Erection Department.

and Co., Willans Robinson, and the United Electric Car Co., and is also interested in Electric Supplies, J. G. White and Co., and has acquired Siemens Bros.' Stafford works, was formed at the beginning of last year with a nominal capital of £5,000,000. With the consolidation of all these interests, the object being to organise a perfect world sale system,

Small and Medium Machining Department.

the policy was to allot to each of the works the manufacture of motors and dynomos of a kind and size for which they were suitable. Thus the Phœnix do one class of the English Electric Co.'s work, while other types go to the other works.

It has agents throughout the entire world, and by its methods of mass production and economy in all departments it has acquired big contracts every-

where. If all our engineering concerns were organised in the same manner and employed the same modern and quick production methods, our place in the world's markets would be quite secure.

Automatic Machine Department.

Larger Machine Erection Department.

Section of Winding Department.

Standardisation.

The Phœnix works is a splendid example of what may be done by standardisation and the mass production of parts, and the product is a refutation of those—and there are some—who contend that a good finished job cannot be produced by these methods. It is by the production of special sizes and types, and first-class workmanship, that it is possible for the Phœnix to sell, at a low cost, work that will stand the most rigid tests.

Always Progressive.

The Phœnix works have always been progressive. Designs are all the time being improved upon, and while supplying the world's markets its development has been guided considerably by the needs of the great industries of Yorkshire, notably wool and coal-mining. It was from the nucleus of a local reputation that it has developed its present big business at home, in the colonies, and in foreign countries.

THE EMPIRE'S RESOURCES IN TIMBER.

Movement in Direction of Substantial Development.

"The timber of the world has been ruthlessly slaughtered," declared Lord Selborne at the Empire Timber Exhibition, which was opened at Holland Park Skating Rink, London, on the 5th ult. The exhibition, which remained open for a fortnight, was organised by the Overseas Department of the Board of Trade, and timber was shown from practically every wood-producing country in the British Empire. It was a practical move in the direction of stimulating forestry in every part of the Empire, and it is hoped to establish a permanent Imperial Forestry Bureau, to become the centre and means of circulating commercial information and technical knowledge of forestry.

Lord Selborne said there was a likelihood of a very real shortage of timber for the world's consumption. English and Scottish forestry required to be remodelled and reorganised to meet foreign interests. It was necessary to have properly-constituted forest authorities in every part of the Empire, while British builders and others should realise that a great deal of the timber they obtained from abroad could be grown in these islands.

In declaring the exhibition open, Prince Arthur of Connaught said that was the first occasion upon which a representative collection of timber from His Majesty's dominions had been gathered together. Timbers of great beauty from India and the Colonies had been sent which had seldom been seen in England. At the same time, the home-grown exhibits would astonish those who did not realise the quality and variety of timber which could be produced in the British Isles. The experience of the great war had taught them the danger of dependence on foreign supplies. In 1913 not less than 90 per cent of our timber and timber products came from abroad, and the necessity for providing our fighting forces with material, and to maintain our fuel supply, had made terrible inroads upon our woodlands at home. The British Empire Forestry Conference, whose members he welcomed there, represented the forestry interests of every part of the Empire, and their efforts and deliberations should ensure the realisation of his confident hope that the exhibition would serve a great and useful purpose.

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By Eric M. Bergstrom, of London.
Associate Member of the Institution of Mechanical Engineers.

(Continued from Vol. VII., page 308.)

Testing plants which have proved so valuable in the development of the design of runners are now installed within the works of most European turbine manufacturers, although in America most tests are carried out at the famous testing plant at Holyoak. Not only are standard runners accurately analysed on these testing plants, but all new special designs are subjected to test, and in the case of turbines, whose large capacities do not permit of testing, accurate geometrically similar models of small diameter are made for testing purposes, and the results represent very accurately the performance of the master runner.

The importance of proper tests and rational research work, where the conditions bringing about the best results can be definitely ascertained, has perhaps in few instances manifested itself so clearly as in the evolution of the Francis turbine, the development of which has only been possible by exhaustive trials and by intelligent application of the results obtained.

As a point of interest, in view of the importance of this subject to realise fully the limitations and advantages of various types of runners, a brief reference will be made to the tests and the methods employed to analyse the results.

The tests for the purpose of investigating the chief characteristics of runners in order to determine their performance under a varying set of conditions are carried out in specially-prepared testing flumes, the turbine being generally placed in a vertical position with the runner suspended from a ball suspension bearing to reduce the mechanical losses to a minimum. A Proney brake is usually employed for recording the output, and the quantity of water measured by means of an accurate weir, by floating vane in a specially prepared channel, or by a large tank of known dimensions; the latter practice is not often adopted, but is certainly the most accurate method.

These tests are distinct from, and should not be confused with, the commercial tests carried out *in situ* after the erection of a plant, in which, owing to the entrance losses in the casing and larger mechanical losses due to friction in bearings, the efficiency recorded may fall considerably below the values obtained by the same runner at the testing plant.

The author considers it necessary to make this observation, as it is often the case that the efficiencies obained from turbines of different makes are indiscriminately compared without reference to the conditions under which the test has been carried out. It is easily recognised that the efficiency obtained from a particular turbine, for instance at the Holyoak testing flume where efficiencies of over 90 per cent have been obtained, is by no means commensurate with the efficiency obtained from a plant under actual working conditions when a maximum efficiency of 86 per cent would be considered exceedingly good; the former owing to the ideal conditions under which the test has been carried out representing as nearly as possible the hydraulic efficiencies of the runner only, whereas in the latter case the total efficiency of the plant under commercial load is represented.

During the tests in the testing flume the head is maintained as constant as possible, and the output and efficiency obtained at the various speeds and gate openings are plotted in diagrams with the speed as abscissa and the output and efficiencies as ordinates,

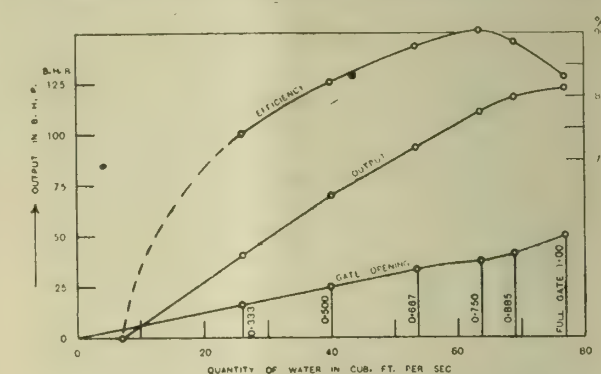


Fig. 2.—Test Results of Francis Turbine designed for Head H = 17·3 feet. Output P = 124 B.H.P. Speed N = 187 r.p.m. Specific Speed = N_s = 59.

when a "speed-power" and a "speed-efficiency" curve is obtained for a number of different gate-openings.

The power and efficiency curves at normal speed, which is the speed for which the runner has been designed, and if correctly designed the speed at which the maximum efficiency is obtained, can now be plotted in a diagram as shown in Fig. 2. This diagram has been computed from a test at Holyoak with

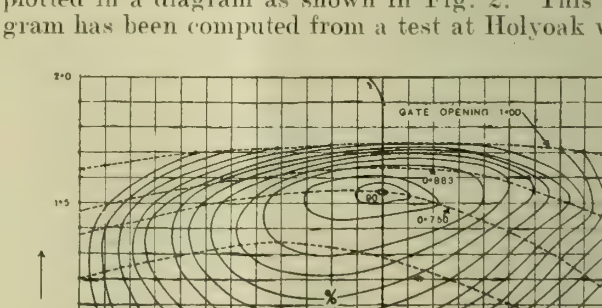


Fig. 3.—Characteristic Curves for Francis Turbines at Various Gate Openings.

a runner of a specific speed of 59 (260) and gives the values of output and efficiency of the runner under a head of 17·3 ft. at a normal speed of 187 revolutions per minute.* This diagram, however, cannot be used to determine the behaviour of the runner under other conditions, and a diagram of the "general characteristics" of the turbine must be drawn as shown in Fig. 3, representing one of the several methods

* Trans. Am. Soc. of C.E., Vol. lxvi., 1910.

devised for this purpose. In this diagram all the values obtained from the tests have been reduced to the values corresponding to the unit head of 1 foot with the unit speed as abscissæ and the power as ordinates, the efficiency being plotted as continuous parabolic curves.

The method of drawing these curves is as follows: The speed-power curves under the unit head and at the various gate openings are first drawn, as shown in dotted lines on the diagram. From the speed-efficiency curves we find the speeds at which, with the different gate-openings, the same efficiencies are obtained and mark these speeds on the corresponding speed-power curves and draw a continuous curve through the points so obtained. This process is repeated to cover the full range of efficiencies obtained from the test and the diagram is completed.

The use of the diagram is just as interesting as it is simple. Assume that the turbine as represented by this diagram is selected to work under a head of 25 feet, the power developed at full gate would then be:—

$$P = 1{\cdot}73 \times 25 \times \sqrt{25} = 216{\cdot}25 \text{ B.H.P.}$$

and the normal speed:—

$$N = 45 \times \sqrt{25} = 225 \text{ revolutions per minute,}$$

and the efficiencies the same as those shown in the diagram for the normal unit speed of 45 revolutions per minute.

Assuming, however, that it is required for some reason that the turbine should run at a speed of 250 revolutions per minute instead of 225, the corresponding unit speed would be:—

$$250 \div \sqrt{25} = 50 \text{ revolutions per minute.}$$

The efficiency corresponding to this new condition of speed can be directly read off from the diagram, which shows that the increase of speed to 250 revolutions per minute for this particular turbine would entail a considerable loss of efficiency, the values being:—

	per cent.
1·00 gate	82.5
0·883 ,,	87
0·750 ,,	85
0·667 ,,	81.5
0·500 ,,	74

At normal speed, the efficiency would have been:—

	per cent.
1·00 gate	84
0·883 ,,	88
0·750 ,,	90
0·667 ,,	87.5
0·500 ,,	82

On the other hand, assume that the speed of 225 revolutions per minute is kept constant by means of a governor, and that the head is increased to, say, 36 feet, the unit speed would then be:—

$$225 \div \sqrt{36} = 37{\cdot}5 \text{ revolutions per minute.}$$

and from the diagram we find that the unit power at full gate is 1·7, corresponding to an output of $1{\cdot}7 \times 36 \times \sqrt{36} = 367{\cdot}2$ B.H.P. This particular turbine, represented by the characteristic diagram referred to, would be known by its normal unit speed $N_1 = 45$ and unit power at full gate $P_1 = 1{\cdot}73$, corresponding to the specific speed $N_s = 45 \times 1{\cdot}73 = 59$ (260).

(To be continued.)

Letters to the Editor.

RESEARCH WORK.

To the Editor of the "Industrial Engineer."

Sir,—Will you allow me, as associated with more than one Committee which is endeavouring to further the cause of industrial research in this country, to make a plea in your columns for greater activity in this direction, and to endeavour to deal with a few of the material requirements which this development involves.

At the present time, when prices are reaching the maximum which can be extracted, while wages still show an upward tendency, improvements in methods of output would appear to be the only hope of maintaining many industries on a sound financial basis, and if markets for our trade are to be preserved we must at least respect research as much as other countries with whose goods we have to compete.

Where this question has not yet been considered, some competent person in the firm should be directed to investigate and report, and should be relieved of routine duties for this purpose; in a business of any magnitude the outlay necessary is comparatively small, and should be faced, not in anticipation of an immediate return, but in the light of an almost certain most generous recompense after a few years. Government grants are now available under certain conditions, either in the form of money given to an approved Research Association set up by firms having common interests, or salaries to research workers for a term of years as "fellowships."

One of the main difficulties at the present time is that of building. There is a real difficulty in getting buildings erected in a reasonable time, while prices are inflated, and the principal object of this letter is to draw attention to the possible use of old buildings for the purpose. Processes and conditions change, and many factories possess old buildings which might be utilised or made partly available by some reorganisation.

It may be truthfully said that a research building should be erected *de novo* for its purpose; at the same time, when this idea is unattainable, much work can be done in converted structures. Some of the best chemical research done at Cambridge 20 years ago emanated from a laboratory which had once been, the writer believes, a stable.

Researches must necessarily differ very much, but any scheme may be considered under the headings: Administration, statistics, pure science, and applied science, among which, or perhaps as a separate entity, the clinical consideration of the workers, upon which efficiency so much depends, might well be included. At the outset it should be realised that the scheme will be likely to grow, and hence possibilities of expansion should be considered, unless the arrangements are to be regarded as temporary pending something better. The director in charge should have an office, and a general office will usually be necessary, which might often serve for the statistical section of the work as well. In some businesses a great deal of charting up of repetition tests may be required, but in all schemes great importance should be attached to extract work in order to keep the research staff up to date, save its highly-paid time in hunting for information, and put at its disposal the latest results of workers the world over. In this section the work of the various sections would be co-ordinated under the director's instructions, both to keep the workers in touch with one another, and to enable him to present reports embodying a complete practical issue to the heads of the firm. Pure science will require laboratories, according to the diversity and scope of the work, for chemistry, physics, biology, or other science with sufficient room to enable workers not to feel impeded and to prevent waste of time in taking down apparatus which may be subsequently wanted. Applied science will require accommodation of a shop type. Here experiments will be conducted on a commercial scale, and the results of the laboratory will be subjected to the ordeal of practical working conditions.

To turn to material considerations, first, efficient lighting, heating and ventilation are as necessary in a laboratory as they are now recognised to be in workshops; indeed, on mere commercial grounds they are more necessary, as salaries are higher here, and any aid to efficiency will pay. A north or east light is best for laboratory work, particularly when microscopic investigations are required, and old buildings will often need more windows or top lights, but much can be done by suitable wall and ceiling treatment. If additional heat is required rings of steam-pipe near the ceilings are effective, cheap, and do not encroach on wall space, or, in the absence of steam, low-pressure hot-water, possibly accelerated by a small motor pump, is

usually most suitable. Cross-ventilation by windows, though often effective enough in many rooms, must be supplemented by fans in laboratories for chemical and some other classes of work. As to treatment of walls and floors, so much of the former are taken up by fittings that a great deal of the costly glazed brick and tile work often found in laboratories is really quite unnecessary. Except round sinks and in fume cupboards, ordinary distemper is quite suitable, and if this is on bare brickwork fixing things to walls is facilitated. Even tiles may be obviated to some extent where distemper is unsuitable by the use of white cement trowelled to a fine face. For administrative rooms, biological, and even some physical laboratories, nothing is better for floors than good linoleum, which may be laid direct on cement, care being taken beforehand to make good any surface inequalities. Asphalte forms a comparatively cheap and very serviceable floor surface for laboratories and corridors, and can be laid on old boarded floors, which, however, must be well ventilated, to avoid "dry rot." Terrazzo for corridors and wood blocks for laboratories are nicer, but more costly. Compressed cork again makes a beautiful floor, and has been used in America. If new cement (cheapest of all) is to be laid for corridors, it should always be made with granite chippings to avoid the otherwise inevitable wear and dust.

Laboratories, or at least those for chemical work, will require special drains. Wastes from the fittings should not be trapped, but discharged into open and accessible channels, generally in glazed ware, but which may be quite effective in asphalte, if organic liquids are little used.

As to fixed fittings, though delicate instruments require good cases, much simplification of the usual laboratory furniture might be effected when funds are limited. For example, fume cupboard bases of concrete finished in fine cement and well coated with a resisting paint, would be very serviceable, and such tops might possibly be used for working benches, which are usually, however, of teak, though tiles have recently been successfully adopted, and enamelled lava is used in France, but is costly. The question of the simplification of laboratory fittings and the use of cheaper materials is being debated by an authoritative conference, and it is to be hoped that useful, practical results may be the outcome. For actual research, as distinct from routine bench work, the fewer fixed fittings a laboratory contains the better. Gas, water, electric, and other services should be confined in such rooms to narrow wall shelves or tables. Upon such fittings, and many other matters of detail many firm will possess scientists well able to advise, whilst in the initiation of a temporary scheme or utilisation of old buildings here urged for an immediate beginning, a works foreman could often supervise the necessary alterations decided upon.

I am, sir, yours, etc.,

9, Old Square, Lincoln's Inn, London. ALAN E. MUNBY.

Foreign Notes.

PURCHASES OF GERMAN METAL BY JAPAN.—According to the *Berliner Tageblatt*, the Eisen und Stahlwaren Industriebund, of Elberfeld, reports that Japan has placed orders with German firms for several million marks' worth of refined sheet metal.—Reuter.

NO BIDS FOR U.S. WOODEN SHIPS. No buyers have come Department offers for sale, under sealed bids which will be opened on the 4th August, 2,385,000 lb. of zinc, representing the surplus stocks of the various naval stations.—Reuter.

NO BIDS FOR U.S. WOODEN SHIPS. No buyers have come forward for the 21 wooden ships built as part of the war programme and for which bids were invited by the Shipping Board. Tenders were to have been opened to-day, but none were received. The wooden vessels aggregated 82,800 deadweight tons.—Reuter.

U.S. STEEL TONNAGE REPORT. The monthly unfilled tonnage report just issued by the United States Steel Corporation shows unfilled orders on its books as on June 30th of 10,978,817 tons. This compared with 10,940,466 tons on May 31, an increase of 38,351 tons, and with 4,892,855 tons on June 30th, 1919. Reuter.

MOTOR RAILWAY COMPANY FORMED IN JAPAN. A company called the Hanshin Jidosha Tetsudo Kabushiki Kaisha (The Osaka-Kobe Motor Railway Co. Ltd.) has been formed to inaugurate a motor railway service between Osaka and Kobe. Tracks will be laid along the present State road, and ten passenger and eight goods cars will be run. The company's capital is 5,000,000 yen.—Reuter.

RUMANIA ORDERS SPARE PARTS IN U.S.A.—The Baldwin Locomotive Works, Philadelphia, has received another important order for spare parts for locomotives from Rumania, and shipment will be promptly made. The terms of payment are cash against documents, the Rumanian Government having established a bank credit in the United States.—Reuter.

TENDERS INVITED BY THE VICTORIAN RAILWAY.—The Victorian Railways Commissioners invite tenders closing August 25th for the following: Material for locomotives, C.S. wheel centres, solid drawn steel superheater elements, best steel boiler plates, cope and half-round M.S. bars, copper plates, steel channel bars, M.S. angles and tees, locomotive seamless copper tubes and pipes, solid drawn brass or copper boiler tubes, lubricator copper rod, solid drawn copper or steel flue tubes, steel tyres, M.S. sheets and hoop, round and flat spring steel, solid drawn steel tubes, M.S. plates, Yorkshire iron or mild-steel boiler angles, steel blooms, and best Yorkshire bars. Separate contracts P.D. ½ per cent in each case.—Reuter.

GOVERNMENT AMALGAMATION OF ELECTRICAL ENTERPRISES IN JAPAN.—The expansion of electrical enterprises in Japan was one of the most prominent features of the war trade boom. With the sudden slumps in the financial world, and the refusal of bankers to advance credits, however, many of these schemes have become unworkable, and te Government is now intending to amalgamate all electrical enterprises, thus hoping to stabilise the industry. How greatly the shortage of funds has affected the trade may be seen from the fact that the Nippon Electrical Association and other similar big enterprises have been applying to the Bank of Japan for funds. The Ministry of Communications, which has also been asked to render assistance, is apparently of opinion that the advance of capital to the promoters is a temporary measure, which will not place the industry on a permanent basis. The Government, therefore, issued instructions to prefectural governors recently that electric industries should be amalgamated under the direction of the local authorities and that power enterprises should be managed on a greater scale than now planned. In the opinion of the Ministry of Communications, this amalgamation of plans and the enlargement of enterprises will not only render the exploitation of water power easier and more economical, but will also make it easier for the promoters to raise capital. The advance of capital asked for is considered of secondary importance by the overnment.—Reuter.

Trade Items, Notes, &c.

INTENDED for the coasting trade, the welded motor ship, built by Cammell, Laird and Co. Ltd., Birkenhead, has carried out successful sea trials. Not a single rivet has been used in her construction, the hull and all the tanks, etc., being welded throughout. The vessel is 150 ft. in length, and is fitted with the Cammellaird Fullagar type of main oil engine.

SPANISH HYDRO ELECTRIC CONFLICT.—A Madrid correspondent reports the presence there of an official Portuguese committee, in order to negotiate direct with Spain on the important question of using the water power of the Duero river. This water-course constitutes the boundary between Spain and Portugal for a distance of about 150 kilometres, and the total fall along that stretch amounts to 420 metres. The water volume is very varied. In midsummer it amounts to no more than 20-25 cubic metres per second, increasing during rainy weather to several thousand cubic metres, with overflow of the banks of the river besides. The navigable part is in Portuguese territory. In the year 1866 an agreement was made between Spain and Portugal in virtue of which the use of the international Duero for irrigation or for power purposes could only take place by special agreement between the two Governments for each separate case. Since 1902 several Spaniards have applied for and obtained isolated concessions of falls in the stretch of river in question; but in the year 1912 all concessions were acquired by a powerful Basque consortium, which had in view the installation of great hydro-electric works. These include dams to contain water, with a surface of 4,000 hectares. The regulation of the quantity of water naturally favoured the navigation

and irrigation plants in Portuguese territory, without Portugal having to be at any expense in the matter. It is calculated that the water power available is equal to 300,000 H.P., whilst the natural falls existing make quite 70,000 H.P. The question arising between the two countries is as follows :—In the agreement of 1866 it is set out in a supplementary paragraph, that the water power of the international section (of the river) belongs to both States in equal parts, therefore, Portugal insists that thus 150.000 H.P. of the project should come to her; whilst Spain, her neighbour, proposes only to allow her half of the natural waterfalls, viz., 35,000 H.P., and to shut her out from any share in the new values created purely by Spanish labour and Spanish capital. The Press has been busy discussing the respective merits of the claims for months, and it is hoped that the negotiations with the committee referred to above will find a solution to the difficulty.—*Electrical Industries.*

Electric Company's Continental Interests.—An Antwerp report mentions recent rapid developments in the influence of the English Electric Co. on the Continent. A short time ago the French electrical engineering firm, the Société Anonyme des Constructions Electriques de France, which was formed in 1918, increased the capital to 40 million francs, and a large proportion came into the hands of the English Electric Company, whose processes and patents will be worked by the Paris firm. The French firm have acquired new works in Epinal, and have secured a large proportion of the contracts so far given out in connection with the extensive scheme of electrification of some of the French railways. By substituting hydro-electric power for steam power on the Orleans Railway alone, it is estimated that an annual coal saving of over $1\frac{1}{2}$ million tons will be effected. Through their large holding in the French undertaking, the English Electric Company have also an impotant interest in a Belgian group.

Big Patents Boom.—There is an extraordinary boom in inventions. During the first half of this year 17,994 applications were made for patents—an increase of about 2,000 over the corresponding period last year. No fewer than 3,100 applications were filed during the first 12 days of the present month, compared with nearly 1,100 for the same days of 1919. Before the war the highest number of applications was 30,388 in 1910, and 40,000 are expected this year.

Starting Gear for Beardmore Aero Engines.—The starting gear for the Beardmore engine operates on what is probably the simplest principle at present in use. It consists of three essential parts : (1) A magneto operated by hand; (2) a pump for pumping petrol; (3) a gear for turning the engine by hand. The operation of the system is as follows :—A small quantity of petrol is injected into each of the six inlet valve pockets of the engine. The engine is then turned by the gear to compress the mixture drawn in from the pockets, and immediately the hand magneto is operated, igniting the injected petrol, the engine then, of course, functions on the carburetter supply. There is one feature of the Beardmore scheme which is of note, viz., that enough petrol is injected into the inlet pocket and piping to keep the engine running for several revolutions, which gives it the opportunity to establish a good suction on the carburetter. A standard type of hand-starting magneto is used, as on most other systems. The Doping pump is of very simple design, having only two ball valves. The pump and petrol reservoir are one piece, the pump barrel being a small tube inside the large one comprising the reservoir. The two valves and the pump piston comprise all the moving parts. When the petrol is forced out of the pump to the inlet valve pocket, it is not allowed, as in some cases, to enter the pocket in a solid stream, but is made to force a small coned valve off its seat. This valve is spring loaded, and has its lift limited to a very fine amount, thus breaking up the stream of petrol into a very fine spray, and assisting materially in obtaining easy startin. The gear for turning the engine is located on the rear of the camshaft, and is compact. Briefly, a flange on which clutches are cut is bolted to the camshaft driving wheel. The existing casing for the timing gear is taken off, and a casing carrying a worm and wormwheel substituted. Inside the wormwheel is a sliding piece, having clutches cut upon it to engage with those formed upon the flange on the camshaft driving wheel. This sliding piece is held out of engagement by a spring-operated lever, by means of which the gear is connected to the pilot's cockpit in the machine. In addition, for turning the engine from the cockpit, a chain or other drive is connected to the worm shaft, thus enabling the engine to be started without leaving the seat.

Patent Applications.

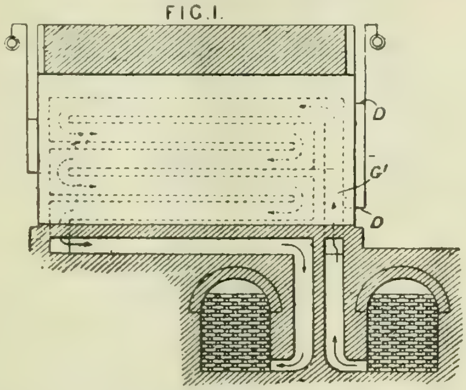
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

COKE OVENS.

129,433.—W. Colquhoun, Endcliffe Crescent, J. Marr, 86, Mona Road, and Coke Oven Construction Co., 155, Norfolk Street, all in Sheffield.—July 9th, 1918.—In a regenerative oven having two series of horizontal heating-flues arranged side by side in each dividing-wall, two vertical air-supply and heating flues are arranged at one end to communicate with the top horizontal flues. As shown in connection with reversible regenerators, the

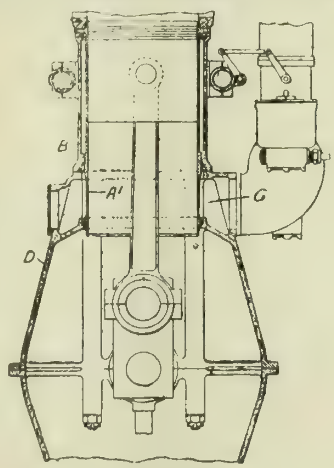
FIG. 1.



vertical flues, one of which is indicated by dotted lines at G1, supply heated air for the combustion of gas introduced into them at D, D, when the direction of flow is as indicated by arrows; when the direction of flow is reversed, these flues act as waste-gas flues, gas being introduced into the heating-flues at the other end of the oven. In a modification in which a continuous regenerator is employed, the vertical flues G1 serve as air and combustion flues only, and another single vertical flue at the other end supplies additional air to the lower horizontal heating-flues.

INTERNAL-COMBUSTION ENGINES.

131,385.—H. R. Ricardo, 21, Suffolk Street, Pall Mall, London.—June 10th, 1918. Air is heated by passing it through an annular



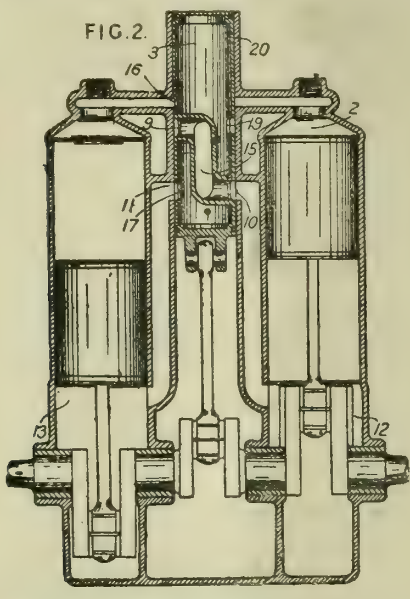
space G surrounding the cylinder barrel or liner A1 and situated between the crank chamber and the water jacket B. The space is shown formed in the upper end of the crank casing D.

INTERNAL-COMBUSTION ENGINES.

131,387.—J. T. Booth, 69, Stafford Road, and R. E. Green, 48, Radnor Road, both in Handsworth, Birmingham.—June 13th, 1918.—The invention consists in applying to engines having single cylinders or using crank-case compression, the valve described in the parent Specification. In the construction shown in Fig. 2, a transverse passage 9 in a piston valve 3 registers at its ends with ports 10, 11 communicating with the supply and delivery passages of a pair of crank chambers forming pumps. The passage 9 in the valve has a port 15 which opens into a supply pipe from a carburettor. In the position of the parts shown

in Fig. 2, the pump 13 is delivering a charge to the combustion chamber through the ports 17, 16 and the interior of the valve, the pump 12 inducing the charge through the port 15. Ports 19, 20 place the pump 12 in communication with the combustion space 2. Modified constructions are described in which a piston valve

FIG. 2.



controls a single cylinder and its charging pump. A further modification is described in which the engine has a cylinder and piston of two diameters, the annular space forming a pump.

TURBINES.

131,428.—H. L. GUY, Trevethin, Albany Road, Victoria Park, Manchester, and BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., 2, Norfolk Street, Strand, Westminster.—Aug. 16th, 1918.—In turbines comprising sections adapted at times to rotate idly steam for cooling is supplied to these idly rotating sections by a special pipe or passage, as distinguished from a channel in the packing gland through which leakage steam can be supplied from one section to another. The cooling steam may be taken from an operative turbine section in which it has been cooled as the result of doing work. Fig. 1 shows high-pressure ahead and reverse sections 4, 5 on one shaft and low-pressure ahead and reverse sections 6, 7 on another shaft. A pipe 10 having a hand-controlled or non-return valve 11 permits steam to pass from the operative section 4 to the idle reverse setions 5, 7. When the reverse sections are operative, a valved pipe 13 leads steam to an intermediate stage of the idle ahead section 4. Another

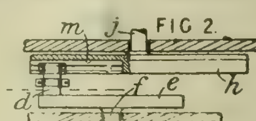
FIG. 1.

valved pipe 14 may supply steam to the idle ahead section 6. In some cases a valveless pipe 17 may be arranged to supply steam for cooling from the ahead to the reverse sections, or *vice versa*, depending on which sections are operative, the ends of the pipe 17 being so positioned that a greater quantity of steam is passed from the reverse section to the idle ahead section when the turbine is going astern than when the opposite conditions prevail, assuming that the disc friction and windage of the ahead section is greater than that of the reverse section. The pipe 10 may be dispensed with by designing the gland 21 to provide sufficient leakage steam to cool the smaller reverse sections when running idle, additional steam for cooling the larger ahead sections when running idle being supplied by a pipe such as 13. Applications of the invention to a turbine comprising cruising and full power sections and to a combination of a back-pressure turbine and a high-pressure turbine are described.

INTERNAL-COMBUSTION ENGINES.

131,427.—T. B. OTHEN Moorlands, North Currie, near Taunton, Somersetshire.—Aug. 16th, 1918.—A crank-pin d on a disc e rotates

FIG. 2.



about the axis of a shaft f carries a block which slides in a slot m formed in a disc h rotating about the axis of a shaft j mounted eccentrically to the shaft f.

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CONTENTS.

EDITORIAL.

INVENTION IN THE WORKSHOP.

THE war period was prolific in inventions. The country's peril acted as a stimulus to men who had never previously thought of originating anything. A record of the inventions during those awful four and a half years would be a wonderful story of mental achievement. We all heard of the big things that appealed to the imagination, but not of the countless improvements and modifications that, by accelerating production, economised our man-power.

The engineer's workshop always has and always will give great scope for inventive talent. That it is not as rare as we used to think it, was proved from 1914 to 1919. It is the incentive that is lacking, a quickening influence that will tune men's minds to a high pitch of endeavour.

The story that Mr. J. Hamilton Gibson, O.B.E., M.Eng., the well-known engineer, tells in the "Camel," the works magazine of Messrs. Cammell Laird, Birkenhead, is as instructive as it is interesting. It is the more valuable that it is not conjecture, but his actual experiences as an engineering works manager.

"The best establishments," he says, "are those that keep an open mind and a keen perception for any hint that promises something better. The management continually finds itself up against the necessity for devising some new method to speed up production of some essential part to keep pace with the rest of the work, or some little contrivances put into operation that prove to be much superior to existing methods, and the improvement can be expressed in time saved and money gained."

The suggestion as often stagnates thought as it ineffective. Rightly or wrongly, there is the suspicion in the workman's mind that he is giving for a paltry sum a brilliant idea worth a fortune. The suggestion as often stagnates thought is it inspires it. If then we pronounce it a failure, what should take its place? Mr. Gibson gives the answer.

"The best scheme in my opinion," he says, "and one that so far appears to work most satisfactorily from the employee's point of view, is to secure the invention by a provisional patent taken out in the joint names of the firm and the employee. The firm pays the patent fees, and if the improvement has already resulted in a real economy, a cash payment to the employee is made on account. In many cases the improved appliance is of such a nature that the firm where it originates cannot very well market the article; it is then handed over to another firm who specialise in such fittings, any royalties that accrue being divided, with a generous bias in favour of the inventor."

Such is the scheme now favoured by some firms, and it appears to us a good one. It would be enlightening to have the views of other engineering managers of long experience on this most important subject.

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By Eric M. Bergstrom, of London.
Associate Member of the Institution of Mechanical Engineers.

(Continued from page 25, Aug. 7.)

By way of comparison a similar diagram of another type of runner is given in Fig. 4.

The selection of the proper type of runner and the determining of the most suitable speed of a plant requires a great deal of consideration, and cannot possibly be adequately analysed with these brief pages, but the foregoing résumé of the evolution of the Francis turbine, together with the fundamental principles and essential facts relating to various designs of runners, enables us to appreciate fully the extent and importance of recent advances in the design of "high-capacity" runners and the value of their application in connection with low head power developments.

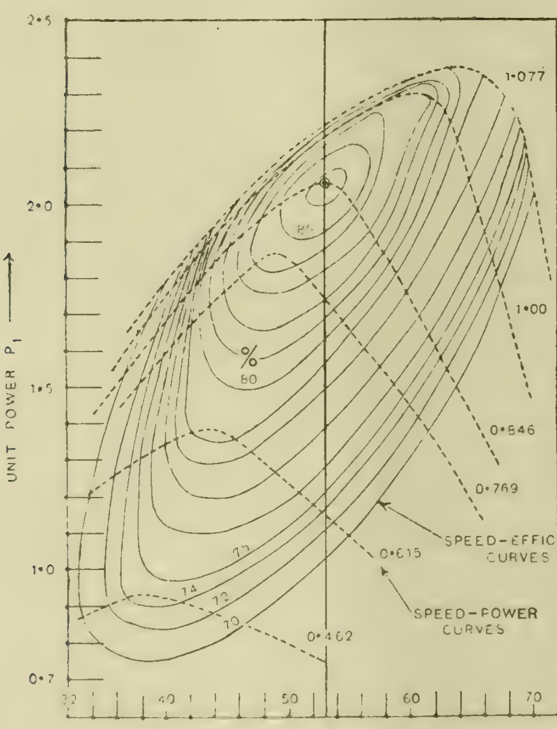


Fig. 4.—Characteristic Curves for Francis Turbines at Various Gate Openings. Normal N_1 = 53 r.p.m. Normal N_s = 78·5.

Reference has already been made to the effect that early attention was paid to increasing the unit speed of runners, the value of which become more apparent with the introduction of direct turbine-driven generators. Considerable study, both theoretical and experimental, has been devoted to this subject, and all attempts at improvements in design of runners during recent years have been in the direction of increasing the maximum value of the specific speed so as to secure a larger output under a given head and speed, or conversely to obtain the highest possible speed for a given head and capacity.

Only nine years ago these conditions could only be obtained at the expense of efficiency which was particularly marked with fractional gate openings, and a strong current of adverse opinion existed against any attempt to increase the specific speed on account of the unsatisfactory characteristics of this type of turbine which would militate against its commercial utility.

The maximum value of the specific speed obtained at that time was approximately 75 (330 metric system), and Fig. 5 represents the maximum efficiencies obtained with runners of various values of

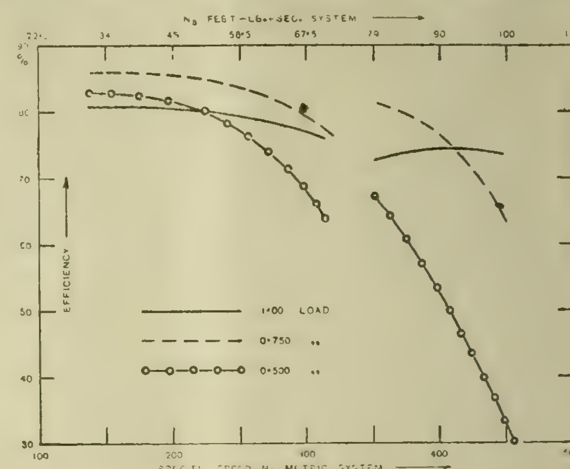


Fig. 5.—Diagram of Efficiencies obtained from Francis Turbines at Various Specific Speeds, 1909.

specific speed, and fairly represents the position at that date.*

Since this time, however, great strides have been made in the development of the high-capacity runner, made possible by the application of the adanced knowledge of the conditions as the result of systematic tests and theoretical investigations. In this respect much credit is due to American engineers, by whom a number of notable installations have recently been

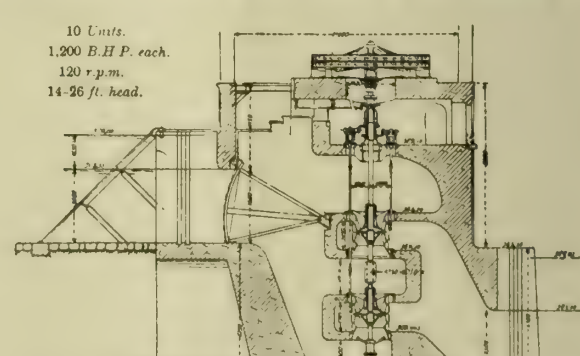


Fig. 6.—Cross Section of Power House at Chevres, Geneva.

carried out, employing turbines with a specific speed of approximately 95 with most gratifying results as regards efficiency. It is now possible to obtain runners of a specific speed of even 100, together with even higher maximum efficiencies than secured previously with a specific speed of very much lower value, and with only comparatively small sacrifice in efficiency at part gate.

* W. Wagenbach. Zeits. fur das Gesamte Turbinenwosen, May, 1909.

The development of the high-capacity runner has had a far-reaching effect on the economical arrangement of units for low-head plants, in addition to obviating many inherent disadvantages in the arrangement of two or more runners on a common shaft, a practice which was adopted to secure a high-speed in order to effect a reduction in the initial cost of directly-driven generators. To cite an instance to demonstrate this point more vividly, reference is made to Fig. 6, showing the power station at Chevres, near Geneva. This plant, erected during 1890–1898, consists of 15 Jonval turbines of the multiple-runner type, each unit having an output of 1,200 H.P. under a maximum head of 26·5 feet and a speed of 120 revolutions per minute, although the five units first installed had a speed of only 80 revolutions per minute. If this plant were built to-day and equipped with high-capacity Francis turbines, a single runner turbine at 120 revolutions per minute would give an output per unit of 2,500 H.P., or conversely with an output of 1,200 B.H.P. the maximum speed would be approximately 175 revolutions per minute. With each unit consisting of a double Francis turbine, a maximum output of 5,000 B.H.P. would be secured at a speed of 120 revolutions per minute, or with the original output of 1,000 B.H.P. a speed of 290 revolutions per minute would be obtained.

This example indicates sufficiently the great value of this latest development in the enormous saving effected in the total cost of the plant, not only on account of a lesser number of units being necessary, but also due to the reduced size of the buildings and

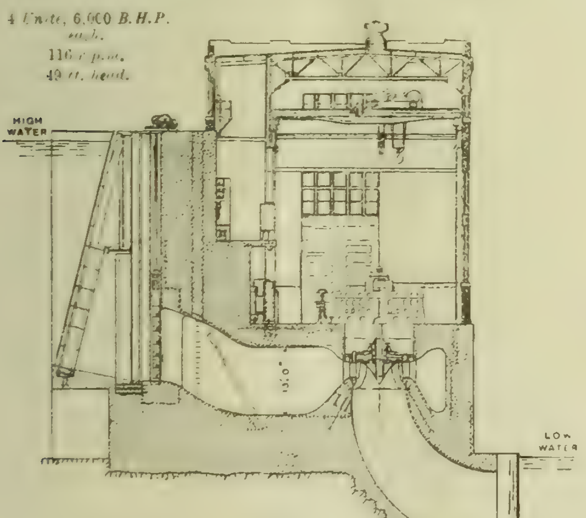


Fig. 7 - Cross Section of Power House, Appalachian Power Co., New River, U.S.A.

foundations. A striking contrast is offered by Fig. 7, showing a section through the power-house of a modern vertically arranged turbine plant, which cannot fail to illustrate the compactness in design and less foundation work as compared with the previous plant.

Although European engineers have been far more conservative in the adoption of runners with high specific speed, the maximum being 80 (350) as installed at present, test runners have been constructed up to a specific speed of 160 (750) with fairly good results.*

Fig 8 shows a design of runner recently constructed by Escher Wyss and Co., which under official efficiency tests gave exceptionally good results at varying speeds corresponding to a specific speed of from 85 to 112 (375–500). The arrangement of this new

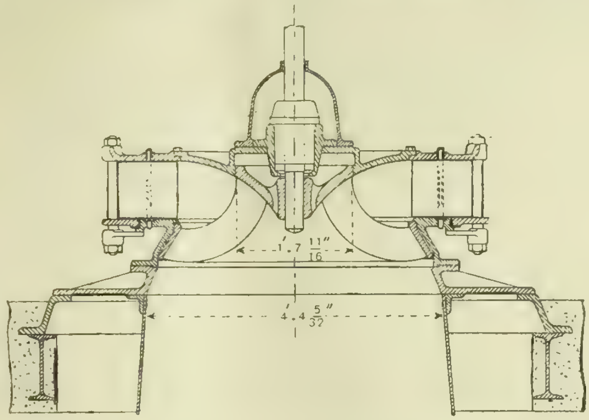


Fig. 8.– New Type of Turbine (Escher Wyss.)

type of turbine is seen from the figure, the main feature being the large space between the guide vanes and the entrance edge of the runner. Hitherto the fundamental idea in all designs of turbines has been to allow a minimum of space between the guide-vanes and runner, and this new departure in design suggests the possibility of reverting to the axial Jonval type of runner, but retaining the convenient form of wicket-gate for regulation purposes. It is anticipated that further progress will soon be recorded on these lines, but at present no further data are available.

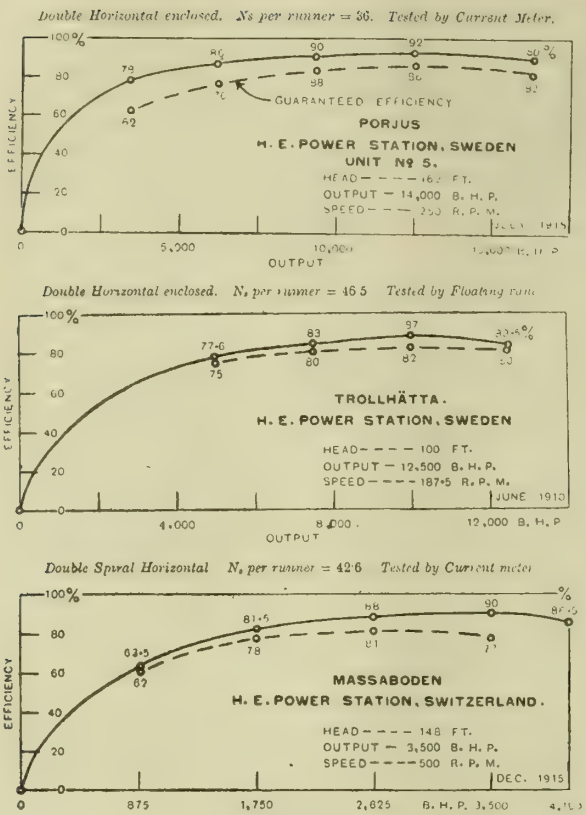
Concomitantly with the development of high-capacity runners is the remarkable increase in the overall efficiencies obtained from plants under working conditions. The increases in the average overall efficiencies have naturally followed in the train of the more careful and correct runner design already referred to, but they are also due to the improvements in the design of casings, guide apparatus, suction-casings, and suction tubes, based on a better understanding of the conditions of flow in various parts of the turbine, thus eliminating as far as possible impact losses and formation of eddies in the water during its passage through the turbine.

The most notable achievements in maximum efficiencies obtained during recent years are recorded in Table 4, and it is to be noted that these figures represent results of test in place under working conditions in the presence of impartial experts, and consequently they can be regarded as highly authentic.

Another significant fact to be recorded is the long range of gate openings for which an efficiency of over 80 per cent is obtained, and which can be seen from the various test curves, Figs. 9–10. In this connection it is interesting to recall that only a few years ago Professor Dr. Prazil,† in the course of a paper on

* H. Th. Holm, "Moderna Vattenturbiner," Teknisk Tidskrift, Stockholm, July, 1914.

† Dr. F. Prazil, "Results of Experiments with Francis Turbines," Pro. I.Mech. Eng., 1911.



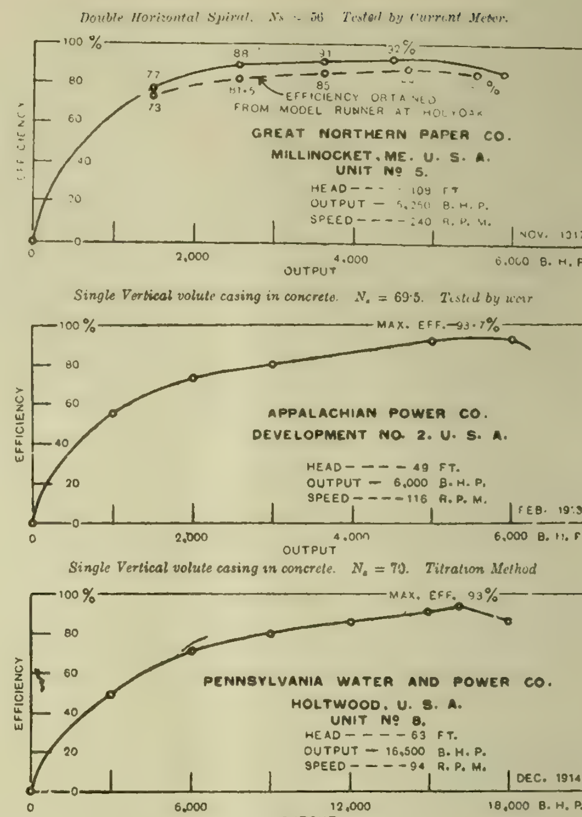


FIG. 9. Turbine Efficiency Curves. See Table 4. FIG. 10.

TABLE IV.

No.	Plant.	Year.	Maker.	Head in ft.	Normal Output.	Speed in R.P.M.	Specific Speed per runner. foot lb	Specific Speed per runner. metric.	Maximum Efficiency — per cent.	Type.	Quantity of water measured by
1	Svalgfos Hydro-Electric Station, Natodden, Norway.	1908	J. M. Voith	150	11,750	250	36	160	85·16	Double enclosed horizontal	Floating vane.
2	Reinfelden Hydro-Electric Plant, Switzerland.	1908	Escher, Wyss & Co.	15	1,200	68	40	177½	87	Quadruple open vertical	
3	Hamilton Cataract Co. Ltd., Canada.	1909	J. M. Voith	261	7,000	286	16	71	86·8	Double spiral horizontal	
4	Trollhättan Hydro-Electric Plant, Sweden.	1910	Nydqvist and Holm	100	12,500	187·5	46·5	206	87	Double enclosed horizontal	Floating vane.
5	Kanderwerk Hydro-Electric Plant, Switzerland.	1908	Escher, Wyss and Co.	205	3,200	400	27·5	122	87·4	Single spiral horizontal	
6	Chippis Hydro-Electric Plant, Rhone, Switzerland.	1911	Piccard, Pictet and Cie	248	6,500	333	19	85	90	Double spiral horizontal	
7	Appalachian Power Co., U.S.A.	1913	J. P. Morris	49	6,000	116	69·5	308	93·7	Single open vertical	Weir.
8	Pennsylvania Water Power Company.	1914	J. P. Morris	63	16,500	94	70	312	93	Single open vertical	Titration method.
9	Porjus Hydro-Electric Plant, Sweden.	1915	Nydqvist and Holm	162	14,000	250	36	159	92	Double enclosed horizontal	Current meter.
10	Massaboden H.E. Plant, Switzerland.	1915	Piccard, Pictet and Cie	142	3,500	500	42·6	189	90	Double spiral horizontal	Current meter and titration.
11	Great Northern Paper Co., Millinocket, U.S.A.	1917	J. P. Morris	108	5,250	240	56	249	92	Double spiral horizontal	Current meter.
12	Forsse Hydro-Electric Plant, Sweden.	1918	Verkstaden	57	3,750	250	80	352	94	Double enclosed horizontal	

Turbine Efficiencies, delivered before the Institute of Mechanical Engineers, predicted that much further advance in the future could not be expected in regard to efficiencies. The average efficiency of the tests then published was 85 per cent, which value has been greatly exceeded, and a general increase of 10 per cent above efficiencies obtained about 12 years ago can now be recorded. These high values of efficiency fully entitle the water turbine, when properly designed, to be ranked as the most efficient prime mover existent.

While on the subject of efficiency tests of plants, it may be of interest to record the increase in the use of the chemical or titration method for measuring the quantity of water. This method is now considered as giving very accurate readings, and from check tests made with current meter the discrepancy in readings averages only 1 per cent to 1·3 per cent.* This method of testing is principally used for large low-fall installations where generally other known methods of measuring large quantities of water are either inconvenient or impracticable.

The efficiency, in itself a valuable asset, is, however, not the all-important feature of modern turbine developments; the improvement in mechanical details and construction and simplicity in design, together with higher standard of workmanship, are all important factors which have contributed to the advances in the utilisation of water-power, by ensuring freedom from breakdowns, continuity of operation, simplicity in working and accessibility to effect repairs, all of which are of vital importance in connection with any power development.

(*To be continued.*)

SULPHUR IN PETROLEUM FUEL OILS: ITS CORROSIVE EFFECTS ON METALS.

Written and Illustrated by James Scott.

The extending use of petroleum oils for furnaces of all kinds makes the subject of their possible sulphur content one of considerable importance. Insufficient practical attention has, I think, been given to this matter.

There is no need to enter deeply into the composition of crude petroleum and its products to understand the various points so far as they concern the mischievous results which accrue from their combustion. They are mostly thick, dark brownish, greenish, or yellowish fluorescent liquids, and contain mechanical impurities such as dirt, sand, asphalt, and organic refuse, besides sulphur. It is with this latter element alone that I propose to deal. Nearly all petroleums contain it, but some have it in much greater abundance than others. Texas and Mexican oils are the worst in this respect; American the least objectionable. The sulphur in American petroleum averages 0·5 per cent, but may reach 1 per cent. In Texas and Mexican oils, however, it often goes above 3 per cent. Highly sulphurous oils have abominable odours.

In refined oils it has, of course, been greatly eliminated, but still may be present in undesirable amounts.

The usual method for extracting sulphur from these oils is by means of copper oxide, a black gritty powder which is capable of absorbing it in surprising quantity. There are other processes, too, but this is one of the most effective.

I have written a great deal upon the subject of sulphur identity in oils for the petroleum press, and I am very well aware that, as a rule, care is taken to avoid, as far as possible, the retention of sulphur in some oils. These are, however, mainly lubricating oils; since it is thought by many that as the sulphur is burnt, small quantities of it cannot do much harm. That is where the mistake is made, and it is one which fully deserves to be thrashed out.

Petroleum oils, being hydrocarbons, should consist chemically of nothing but hydrogen and carbon, and during imperfect combustion should leave no other deposit than a carbonaceous one. The more soot which is left the less effective has combustion been. Contrarily, the less soot there is the better the fuel has burned. This fact is well known. In this case the deposit is simply an extraneous one, and does not usually corrode the metals with which it is engaged.

If, however, sulphur is present its modifications seriously affect the metals on to which they impinge, and absolute corrosion follows. Sulphur has a very strong affinity for metals, with all of which it normally combines to make sulphides.

So serious are the actions of sulphur in metals that the foundryman and metal worker take extraordinary precautions to guard against an amount of it beyond cerain small percentages being retained in their goods. Pig iron is the starting material for all sorts of iron and steel articles, and this customarily holds from $\frac{1}{20}$ to $\frac{1}{2}$ per cent in its freshly poured state. It is subsequently reduced in metal working.

Both grey and white cast iron may contain from 0·15 to 0·2 per cent of it. Here, again, it is modified by manufacturers according to the purposes to which finished goods are to be applied.

In the best foundry work it is considered that more than 0·10 per cent of sulphur is very injurious. It is seldom allowed to exceed 0·075 to 0·085 per cent.

In steels, sulphur combines preferably with any manganese present, forming manganese sulphide, expressed as MnS. This generally occurs as minute round or oval globules. Manganese is habitually added to iron and steel with the definite intention of favouring the attraction of the sulphur content, and, in some instances, both elements pass out together in the slag.

Manganese sulphide is pale dove coloured; ferrous or iron sulphide is black or grey. By the way, the brassy looking crystalline substance in coal is ferric sulphide (*i.e.*, pyrites), and contains more sulphur than occurs in ferrous sulphide.

Manganese sulphide is not so weakening in irons and steels as ferrous or iron sulphide, which occurs chiefly as globules and thin laminæ, or flakes.

Manganese sulphide and iron sulphide are soluble in each other. The better grade steels do not contain either manganese sulphide or iron sulphide, and it is therefore wise to keep sulphur away from these metals.

* A. Streiff, *Engineering Record*, Sept., 1914, page 276.

Sulphur combines in bronzes with the copper to form a brittle network of copper sulphide, known as Cu S_2.

Copper should not contain more than the most insignificant traces of sulphide. Cuprous sulphide is black, or blueish grey. In analysing metals for the sulphur (really sulphide) content it is usual to press a piece of moistened, slightly acidified, photographic silver bromide paper into their polarised surfaces. The consequent chemical reactions, which engender sulphuretted hydrogen, eventually blacken the paper in places corresponding with the positions of the sulphide grains.

Sulphur, in burning in the presence of sufficient air, is converted into sulphur dioxide, and this is capable of being further oxidized into sulphurous and then sulphuric acid. It is this last change which is likely to do most harm, because the acid dissolves iron, and forms whitish or greenish copper sulphate, and dissolves copper and forms blue copper sulphate. The degrees of chemical distinctions as they pass from insoluble sulphides to soluble sulphates, with almost indefinite, intermediate mixtures, cannot be described just now, as they would require too much space. But as I have had specimens of these products from the burning of highly sulphurous fuel oils, I am enabled to speak with positive assertion on the problem.

I believe that it is because of this solubility that much of the corrosive effects of such oils has escaped notice. Moisture—and this is more abundant in furnaces, as steam or vapour, than is thought—absorbs and carries away these salts, so that their presence has not been suspected, or they remain masked by soot. Their removal, however, leaves numbers of minute depressions and holes in the metal, which may get connected up by delicate cracks, followed by peelings. As might be expected, interference of this character might be responsible for the setting up of further mischief of a mechanical source, which could not have been possible except for such preliminary damage. No doubt the sulphuric acid penetrates into the metal as well.

If copper is the metal concerned, and it is blackened or oxidised by heat, or contains oxide as an impurity, the blue sulphate may become very pronounced. I know quite well that there are two opposing views on this subject. Some men insist that, since the temperatures of burning oils and the associated metals are so high, the sulphur gases have no chance to settle or condense upon the solid parts of engines, and so on. But this suggestion could only be correct where fires were never allowed to go down or out. Some of the sulphur dioxide may be freed entirely from the furnace in the escaping gases. It is obvious that, when engines are stopped and cool down, such condensation is possible, and chemical reaction is subsequently accelerated by renewal of high temperatures. Since, however, careful investigators have proved to their satisfaction that sulphurous oils are dangerous, I do not think that anyone should doubt the statements made.

It must be remembered that all oils are not badly contaminated in this manner, although a great many of them certainly are. Moreover, if a man assiduously cleans his fireplaces, engines, etc., after working them—giving them excess and costly attention, as it were—then plainly he does not allow the sulphur time to react with the metals. The most preferable course to adopt, in circumstances such as these, is to use the purest oils obtainable.

In tracing sulphur in petroleum oils, I gently warm a sample and gradually cool it. The sulphur then

Fig. 1.

emerges as transparent crystals of the kind shown in Fig. 1. If the oil is simply evaporated by exposure, the sulphur does not show itself so well. On the other hand, if it is heated too strongly, it vaporises. I generally concentrate the oil by keeping it for a

Fig. 2.

while in an open vessel; the sulphur does not disappear so quickly as the genuine contents of the oil.

In Fig. 2 is shown some steel attacked by sulphuric acid generated from oil- sulphur in the way hitherto described. The spots or crystals are really white at first, but become dirty green when heated. If very strongly heated they yield oxide (rust) and volatile sulphur.

In Fig. 3 is shown some copper similarly attacked, the crystals being very pale blue. In Fig. 4 is shown a mixture of commercial iron sulphate and copper sulphate, evaporated for comparison. There we

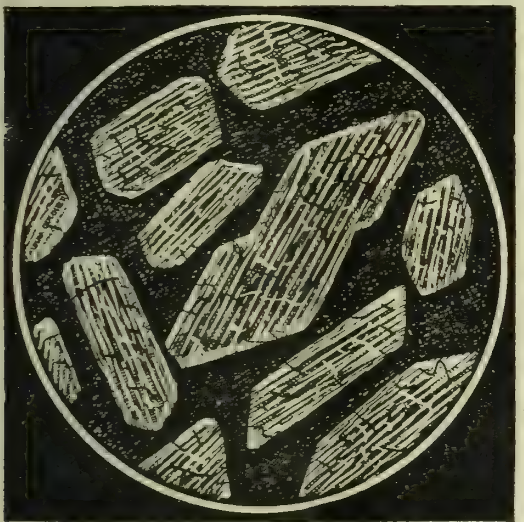


Fig. 3.

have the refined chemicals, whereas on the metals they are impure and hardly strictly nameable. (In this case the salts are shown on opposite sides of glass.)

Fig. 4.

You may have a piece of metal corroded in this way containing scattered crystals of the kind illustrated, yet to the naked eye no such colour is visible.

Mr. Herbert A. Rigg, K.C., has been elected master of the Ironmongers' Company.

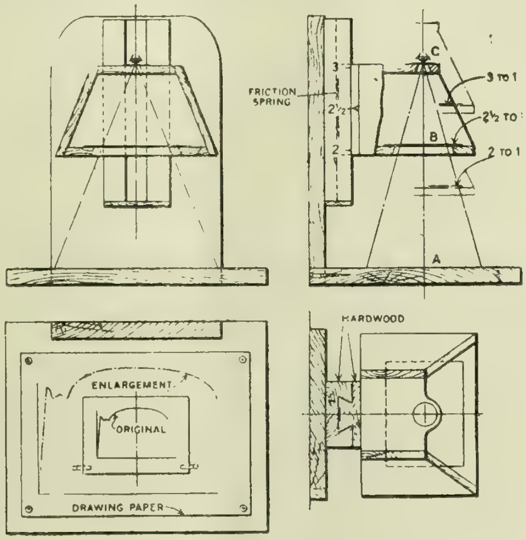
Mr. John Crimmins, a working fitter, of Wigan, has invented a device by which the fastest trains may be pulled up by a signalman.

An international agricultural exhibition, including exhibits of machinery used in agriculture, will be held at Rovigo, in Italy, from September 12th to October 31st.

A PINHOLE PANTOGRAPH.

The writer had occasion recently to use a pantograph for the enlarging of diagrams taken photographically on glass plates. The pantograph used was of French design, taking a considerable time to set up, and a much longer time to replace in its box. The enlargements were, however, eventually made to the required scale of two-and-a-half times full size. While holding the plate and the enlargement in two parallel planes at a suitable distance from the eye to test roughly the similarity of the curves, it occurred to the writer that with a frame containing an eyehole at one end, a small drawing board at the other, and an adjustable frame between to carry the plate, it might be possible to trace correctly by hand to any required scale within the limits of the instrument, an enlargement of the diagram on a sheet of paper pinned to the board.

The simple apparatus shown in the illustration was accordingly made with the most satisfactory results. The enlargements made were carefully tested and



A Pinhole Pantograph.

were found to be more accurate than those drawn by the ordinary pantograph.

A few tests were made to find the correct diameter of the eyehole, and this was found to be 0·04 in. (No. 60 drill). This size of hole showed a clear line diagram with no shadow or parallax. The eyehole was drilled in a thin brass plate 1¼ in. in diameter. The scale of the enlargement depending upon the position of the plate between the eyehole and the board, calibration of the adjustable slide was a simple process and figures, in this case 3, 2½ and 2, were stencilled on the side of the frame representing scales 3 to 1, 2½ to 1, and 2 to 1 respectively, so that the adjustable slide could be instantly moved to the position required. The illustration should be self-explanatory. A sheet of paper is pinned on the board at A; the adjustable slide is moved to the required position and the glass plate inserted at B, and held in position by the two plate springs shown in the drawing. The eye is applied to the eyehole at C, when the diagram will show clearly against the white surface of the drawing paper on the board.

The pen or pencil is then applied to the paper at one end of the diagram as projected on the paper, and the line of the curve followed until the whole diagram is traced. It will be obvious to anyone who has had occasion to use the ordinary pantograph that the use of the simple apparatus described above means a great saving of time—the whole operation of making an enlargement occupying only a few seconds. The apparatus is made entirely of wood with the exception of the steel spring for giving the necessary friction to the adjustable slide, the thin brass plate for the eyehole and the two small plate springs holding the glass plate in position. While the position of the glass plate is not important, the writer found it convenient to draw a base line on the sheet of paper parallel to and at a suitable distance from the edge. The glass plate is then adjusted so that the base line of the diagram coincides with the base line drawn on the paper. The spring clips may then be brought on to the plate to keep it in position. The plates used in the apparatus described above were ordinary photographic half-plates, and the sheets of paper for the drawing board were 14 in. by 10 in. The apparatus was originally designed for enlarging from transparent media only, but when an enlargement from an opaque surface is required a tracing is made directly from the diagram on to an ordinary undeveloped photographic plate fixed in hypo and the plate is then used in the apparatus. Many refinements in the instrument and improvements in design will suggest themselves to anyone interested, as they have done to the writer, but it has been considered advisable to illustrate and describe the apparatus as actually made and used.—*Machinery*.

METHODS OF JUDGING THE EFFICIENCY OF A GRINDING WHEEL.

By R. M. Johnson.

Grinding wheels cannot be accurately compared without keeping records of their action. An operator may report favourably on a snagging wheel, for instance, because it is easy to grind with; in other words, the wheel acts soft. On the other hand, the man who is paying the bills may object to this same wheel because it wears too rapidly. To one, therefore, the wheel is satisfactory, whereas to the other it has very little to recommend itself. Proper records would indicate just how this wheel compares with others, considering all conditions affecting the use of the wheel.

Wheels for different kinds of grinding cannot be judged in the same way. Characteristics which are very desirable in a wheel for cylindrical grinding may make a snagging wheel absolutely unfit for use. At least three classifications of grinding are necessary for our discussion:—

(1) Off-hand grinding such as snagging.
(2) Precision grinding.
(3) Miscellaneous grinding.

Off-Hand Grinding.

By snagging is meant the rapid removal of excess metal from castings by means of a grinding wheel. Our remarks are applicable to steel, cast iron, malleable, and in fact any metal castings. The most important factor with regard to a snagging wheel is how much does it actually cost to grind a unit of the material? The finish is not important.

The total grinding cost includes wheel cost, labour cost, and overhead. It is not a fair comparison if labour and wheel cost are used alone, because overhead is the big item. Overhead per unit of time is constant, whereas overhead per unit ground varies and depends on the production. The higher this production, the lower the overhead per unit. The total grinding cost per hour is not so important as the actual cost per unit of production.

To get this figure one must know wheel cost, labour cost, overhead per hour, wheel life, and production.

Wheel Life.

This is in itself unimportant because from it no idea of the production can be obtained. The true cost per unit cannot be calculated, and the result may be absolutely misleading. If two wheels are compared on the basis of life alone, the result is that the wheel with the longer life is reported as better for the work.

If the operator is asked for his opinion he will report that the wheel which wears out the more quickly is the more satisfactory. His reasons are that it cuts faster than the wheel with a long life, and he does not have to exert as much pressure in grinding.

Production.

The production is the important thing. Combined with the wheel life it is possible to reckon overhead charges, and with this information, total grinding cost per unit.

Production can be obtained in several different units:—

(1) Pounds of material ground off.
(2) Number of castings ground.
(3) Tonnage of castings ground.

The first method can be applied to any type of casting. Both large and small castings can be compared on this basis because the actual material removed is measured. The second and third methods are not as satisfactory because another variable, the size of the castings, is introduced. If castings of the same type and size are being ground, either the second or third method is satisfactory. If the size varies greatly, the third method is better than the second, although either gives only an approximation.

Total Grinding Cost.

From the production per hour, the wheel life and the operator's wages, the overhead, the wheel cost, and the labour cost per unit ground can be calculated. Thus the total grinding cost per unit may be reckoned.

Precision Grinding.

This class includes production grinding to close limits on precision grinding machines. External cylindrical, internal, and surface grinding are all in this class. For a clear and simple discussion, it is a good plan to divide precision grinding into roughing and finishing and consider them separately as types of grinding. Roughing wheels must be of

such structure that stock can be removed rapidly, finish being of no importance. As in the case of snagging, either the cost per pound of metal ground off or the cost per unit of production is the all-important thing. In such a calculation, the wheel cost, labour cost, overhead, wheel life, and total production must be determined. There is an additional item of importance which must be considered —the diamond cost.

All of the items, with the exception of the total production and diamond cost, are similar to those for snagging wheels.

Production.

When wheels are used throughout their life on the same kind of work, such as roughing crank and cam shafts, pistons, and, in fact, any piece which is standard, the number of pieces ground is usually a satisfactory production figure. This is because each has practically the same amount of stock to be removed, so that the number of pieces ground is nearly a measure of the total amount of material removed—the best unit in which production can be obtained.

If the wheels are used for a variety of work, it is impossible to obtain a correct production figure except by going to a great deal of trouble. Cost per unit, therefore, cannot be obtained, and consequently, it is necessary to compare wheels on a different basis. This will be discussed later. There are some jobs where the unit diamond cost is larger than the cost of the grinding wheel. On grinding standard parts, diamond cost can be obtained easily over a period of time, and from this the cost per unit calculated.

The total cost per unit is obtained just the same as for snagging castings except that the diamond cost must be added.

The cost per unit ground cannot be obtained without keeping detailed records which would have to be so comprehensive that the expense would probably not be justified. These wheels must be compared on a different basis.

Assuming that the wheels are cutting satisfactorily, there are two factors which should be considered; wheel life and the amount of dressing necessary—two figures which are closely related, for the wheel which needs least dressing usually has the longest life. The best wheel would be the one with the longest life and fewest dressings, bearing in mind the assumption that the wheels are considered equally desirable from the cutting standpoint.

The finish obtained with a finishing wheel determines the use of that particular wheel for this class of work. After the desired finish is obtained, the wheel which will produce this finish at the lowest cost per unit should be found and used. Such a choice can be determined in exactly the same way as when determining upon the best roughing wheel.

Miscellaneous Grinding.

The classification of miscellaneous grinding includes tool and cutter grinding, general off-hand grinding, and any other operation where production is not important. For work of this type it is impossible to get comparative figures, the operator's opinion of the wheel action being in nearly all cases the deciding factor.

For tool, cutter, and drill grinding, finish is important, for the cutting edge must be keen and there must be no burning. The actual amount of stock removed per wheel is not of fundamental importance, although naturally, if finish and rate of cutting are the same, the wheel having the longest life should be chosen.

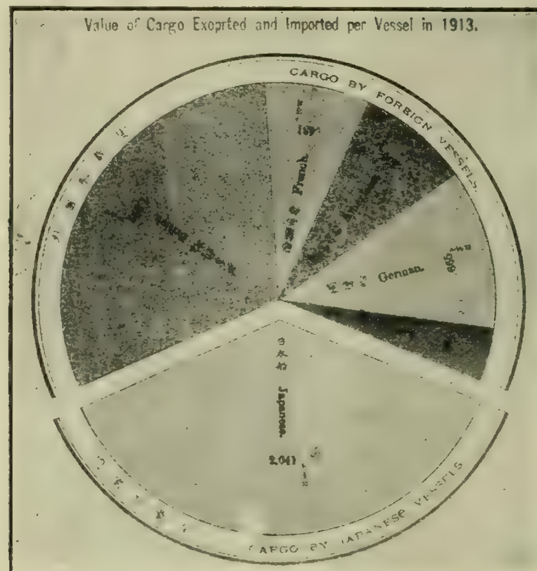
The wheels for off-hand grinding jobs are chosen, not because they last longer, but because they fulfil certain special requirements. A wheel may be used for squaring the ends of rods. Such a wheel must hold its shape so that constant dressing is unnecessary. In most cases a little burning would not be objectionable. On the other hand, for sharpening lathe and planer tools, the wheel must cut cool and the finish must be rather good.—*Grits and Grinds.*

Electric Furnace Development.—At the annual congress of the Society of Chemical Industry, at Newcastle-on-Tyne, on July 14th, a paper by Mr. D. F. Campbell, M.A., A.R.S.M., upon "Recent Developments of the Electric Furnace in Great Britain" was read by Mr. Burton, in the absence of the author. The writer said that in no branch of metallurgy had greater advances been made during the war than in the development of iron and its alloys, giving them materials of extraordinary strength and physical properties. Steel for aero-engine parts owed its power and lightness to the addition of small percentages of metals, the aeroplane wire its strength, and bullet-proof steel its toughness to the addition of suitable alloys, such as those of nickel-chromium, molybdenum or manganese, and the electric furnace had been responsible in most cases for both the reduction of those refractory metals from their ores, and the subsequent manufacture of alloy steel. Electric melting, he pointed out, had enabled them to use advantageously the vast quantities of steel turnings from shell factories. The remelting of nickel-chrome steel was a wasteful and most difficult process in all other furnaces, but the reducing conditions and absolute control of the electric furnace made it possible either to retain or remove, at will, most of the chromium, and thus large quantities of a valuable metal were saved. The economic manufacture of stainless steel had been rendered possible only by the electric furnace which was required both for the preparation of the refined ferro-chrome and steel melting. In 1914 the power used by electric furnaces in Britain, excluding those used for aluminium, was probably less than 6,000 H.P., but on the day of the armistice the total was in excess of 150,000 H.P. The production of electric steel had reached a total of more than 200,000 tons per annum. The manufacture of large quantities of phosphorus by electric furnace methods was necessary during the war, and the excellent fused silica ware for laboratories and chemical works made with such remarkable success on the Tyne, was, perhaps, the most interesting example of the use of the electric furnace for fine work. Electric furnaces owed their value to their intense reducing conditions, as they utilised the only practical source of heat that did not require oxygen for its generation. The utility of the electric furnace did not cease at the end of the war. Shops equipped with electric furnaces for war purposes had been reconstructed, and were producing alloy steels. The manufacture of artificial graphite, a new industry to this country, had been established, and electrodes of a size and quality equal to the best in the world were being produced, and the manufacture of alloys and amorphous electrodes was being developed along the lines of present requirements. The next immediate development would, probably, be the general application of electric smelting to the treatment of complex zinc.—*Electrical Review.*

The report of the directors of the Yorkshire Electric Power Co. for the half-year ended 30th June, 1920, shows satisfactory progress. The cost of coal, labour and materials have been higher during the half-year, but owing to production on a larger scale the profit earned on the larger capital employed has been more than proportionately increased. After payment of bank and other interest, the net profits for the three half-years ending June 30th were: 1918, £23,682 15s. 6d.; 1919, £19,229 1s. 8d.; 1920, £30,146 2s. 2d. The dividend for the half-year on the amount paid on the 6 per cent cumulative preference shares was paid on 1st August.

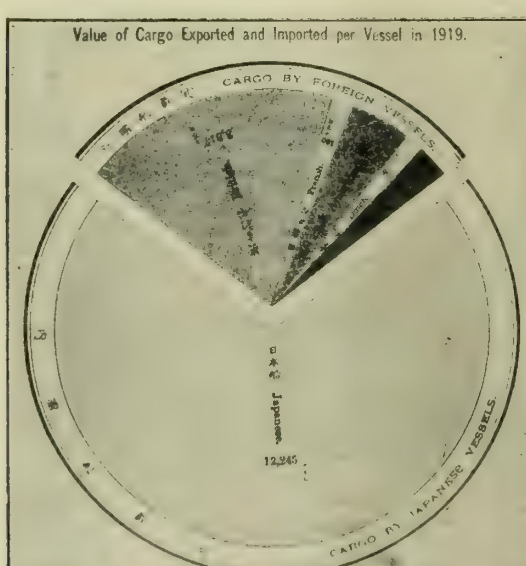
EXPANSION OF JAPAN'S TRADE.

THESE charts, which have been sent to us by the Yokohama Chamber of Commerce, show very clearly



EXPANSION OF JAPAN'S TRADE.—FIG. 1.

the great extension of Japanese trade from 1913 to 1919. Fig. 1 is interesting for the purpose of comparison, but Figs. 2 and 3 are especially of even greater significance, showing, as they do, how our Eastern Allies profited by the great war.



EXPANSION OF JAPAN'S TRADE.—FIG. 2.

Trials of agricultural tractors and ploughs will be carried out at Lincoln commencing on Tuesday, September 28th. The trials are being arranged by the Royal Agricultural Society, in conjunction with the Society of Motor Manufacturers and Traders. Already some 36 competing firms have entered.

THE INDUSTRIAL SECTION AT THE CRYSTAL PALACE EXHIBITION.

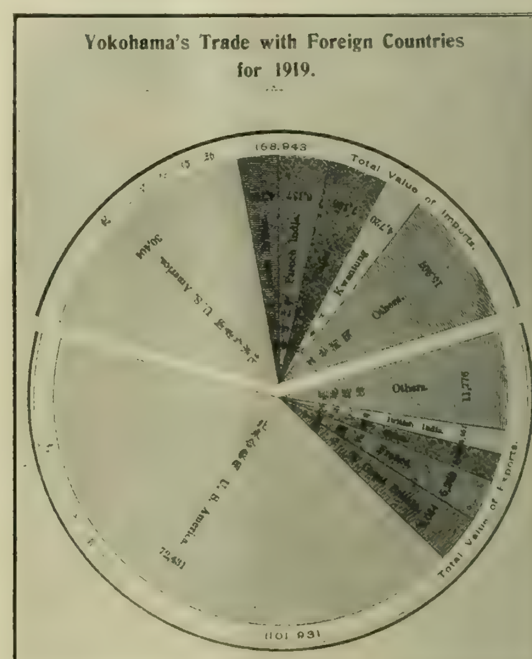
EXTENSIVE DISPLAY BY PROMINENT BRITISH FIRMS.

It is an Englishman's privilege to grumble, and the grumble made by a number of the exhibitors in the industrial section at the Crystal Palace has borne some fruit. Complaint was made of lack of publicity and difficulties of access. The Crystal Palace is not the most central place in London, but the general manager, Mr. H. J. Buckland, after registering a defence of his management, has done something to brighten the industrial section, and is giving it special publicity in certain London daily newspapers, and likewise in a few trade papers.

When a representative of *The Industrial Engineer* visited the Palace on Monday, 9th August, he found an excellent display of exhibits in the oil, engineering, electrical and gas sections. The exhibits are in several large wings away from the main building, but easy of access to the thousands who are daily visiting the numerous war relics which are gathered in the huge building itself.

THE OIL SECTION.

There are upwards of 30 exhibitors in the oil section, and they include such firms as Matthew Wells & Co. Ltd., British Mexican



EXPANSION OF JAPAN'S TRADE.—FIG. 3.

Petroleum Co. Ltd., Sulzer Bros., the Anglo-American Oil Co. Ltd., Mirlees, Bickerton & Day Ltd., J. Samuel White & Co. Ltd., and G. & J. Weir Ltd. The Government Petroleum Department show samples of oil from Derbyshire borings, and a stand is devoted to Polish oil industries.

ELECTRICITY SECTION.

Many labour-saving devices are shown in the electricity section, and the ordinary visitor takes a deep interest in electric clocks, signs, ironers, washing machines, cleaners, suction and blowers, etc. Among the exhibitors may be mentioned Lucking, Cohan, Hutcheson & Co., Chas Beck & Co., Wm. Geipel & Co., the Hooper Suction Sweeper Co., the Rawlplug Co., and the Magic Appliances Ltd.

THE ENGINEERING SECTION.

This, of course, is the principal portion of the industrial section, and exhibits are presented by the leading firms in the kingdom. Vickers Ltd. show locomotive axles, motor car pressings, engineers' small tools of every description, brick and tile making machinery, sewing machines, boxmaking machines, with a stitching machine, a single corner machine and a double-corner cutting machine in operation.

Other companies who show in association with Vickers Ltd. are S. E. Saunders Ltd., Centrifugal Separators Ltd., Ioco

(*Continued on page 16.*)

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × $7\frac{1}{2}$ in. × 91 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 0 14	0 16 1 0	1 4 1 14	1 12 2 0	2 0 2 14	2 8 3 0	2 16 3 14	3 5 0 0	3 13 0 14	0
1	0 3 7	8 3 21	0 17 0 7	1 5 0 21	1 13 1 7	2 1 1 21	2 9 2 7	2 17 2 21	3 5 3 7	3 13 3 21	1
2	1 2 14	9 3 0	0 17 3 14	1 6 0 0	1 14 0 14	2 2 1 0	2 10 1 10	2 18 2 0	3 6 2 14	3 14 3 0	2
3	2 1 21	10 2 7	0 18 2 21	1 6 3 7	1 14 3 21	2 3 0 7	2 11 0 21	2 19 1 7	3 7 1 21	3 15 2 7	3
4	3 1 0	11 1 14	0 19 2 0	1 7 2 14	1 15 3 0	2 3 3 14	2 12 0 0	3 0 0 14	3 8 1 0	3 16 1 14	4
5	4 0 7	12 0 21	1 0 1 7	1 8 1 21	1 16 2 7	2 4 2 21	2 12 3 7	3 0 3 21	3 9 0 7	3 17 0 21	5
6	4 3 14	13 0 0	1 1 0 14	1 9 1 0	1 17 1 14	2 5 2 0	2 13 2 14	3 1 3 0	3 9 3 14	3 18 0 0	6
7	5 2 21	13 3 7	1 1 3 21	1 10 0 7	1 18 0 21	2 6 1 7	2 14 1 21	3 2 2 7	3 10 2 21	3 18 3 7	7
8	6 2 0	14 2 14	1 2 3 0	1 10 3 14	1 19 0 0	2 7 0 14	2 15 1 0	3 3 1 14	3 11 2 0	3 19 2 14	8
9	7 1 7	15 1 21	1 3 2 7	1 11 2 21	1 19 3 7	2 7 3 21	2 16 0 7	3 4 0 21	3 12 1 7	4 0 1 2	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·59	15·18	22·77	1 2·36	1 9·95	1 17·54	1 25·13	2 4·72	2 12·36	2 19·9	2 27·49	3 7	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × $7\frac{1}{2}$ in. × 91 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 1 1 0	8 2 2 0	12 3 3 0	16 5 0 0	20 6 1 0	24 7 2 0	28 8 3 0	32 10 0 0	36 11 1 0	0
10	0 8 0 14	4 9 1 14	8 10 2 14	12 11 3 14	16 13 0 14	20 14 1 14	24 15 2 14	28 16 3 14	32 18 0 14	36 19 1 14	10
20	0 16 1 0	4 17 2 0	8 18 3 0	13 0 0 0	17 1 1 0	21 2 2 0	25 3 3 0	29 5 0 0	33 6 1 0	37 7 2 0	20
30	1 4 1 14	5 5 2 14	9 6 3 14	13 8 0 14	17 9 1 14	21 10 2 14	25 11 3 14	29 13 0 14	33 14 1 14	37 15 2 14	30
40	1 12 2 0	5 13 3 0	9 15 0 0	13 16 1 0	17 17 2 0	21 18 3 0	26 0 0 0	30 1 1 0	34 2 2 0	38 3 3 0	40
50	2 0 2 14	6 1 3 14	10 3 0 14	14 4 1 14	18 5 2 14	22 6 3 14	26 8 0 14	30 9 1 14	34 10 2 14	38 11 3 14	50
60	2 8 3 0	6 10 0 0	10 11 1 0	14 12 2 0	18 13 3 0	22 15 0 0	26 16 1 0	30 17 2 0	34 18 3 0	39 0 0 0	60
70	2 16 3 14	6 18 0 14	10 19 1 14	15 0 2 14	19 1 3 14	23 3 0 14	27 4 1 14	31 5 2 14	35 6 3 14	39 8 0 14	70
80	3 5 0 0	7 6 1 0	11 7 2 0	15 8 3 0	19 10 0 0	23 11 1 0	27 12 2 0	31 13 3 0	35 15 0 0	39 16 1 0	80
90	3 13 0 14	7 14 1 14	11 15 2 14	15 16 3 14	19 18 0 14	23 19 1 14	28 0 2 14	32 1 3 14	36 3 0 14	40 4 1 14	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	40 12 2 0	81 5 0 0	121 17 2 0	162 10 0 0	203 2 2 0	243 15 0 0	284 7 2 0	325 0 0 0	365 12 2 0	406 5 0 0	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 92 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 0 24	0 16 1 20	1 4 2 16	1 12 3 12	2 1 0 8	2 9 1 4	2 17 2 0	3 5 2 24	3 13 3 20	0
1	0 3 8	9 0 4	0 17 1 0	1 5 1 24	1 13 2 20	2 1 3 16	2 10 0 12	2 18 1 8	3 6 2 4	3 14 3 0	1
2	1 2 16	9 3 12	0 18 0 8	1 6 1 4	1 14 2 0	2 2 2 24	2 10 3 20	2 19 0 16	3 7 1 12	3 15 2 8	2
3	2 1 24	10 2 20	0 18 3 16	1 7 0 12	1 15 1 8	2 3 2 4	2 11 3 0	2 19 3 24	3 8 0 20	3 16 1 16	3
4	3 1 4	11 2 0	0 19 2 24	1 7 3 20	1 16 0 16	2 4 1 12	2 12 2 8	3 0 3 4	3 9 0 0	3 17 0 24	4
5	4 0 12	12 1 8	1 0 2 4	1 8 3 0	1 16 3 24	2 5 0 20	2 13 1 16	3 1 2 12	3 9 3 8	3 18 0 4	5
6	4 3 20	13 0 16	1 1 1 12	1 9 2 8	1 17 3 4	2 6 0 0	2 14 0 24	3 2 1 20	3 10 2 16	3 18 3 12	6
7	5 3 0	13 3 24	1 2 0 20	1 10 1 16	1 18 2 12	2 6 3 8	2 15 0 4	3 3 1 0	3 11 1 24	3 19 2 20	7
8	6 2 8	14 3 4	1 3 0 0	1 11 0 24	1 19 1 20	2 7 2 16	2 15 3 12	3 4 0 8	3 12 1 4	4 0 2 0	8
9	7 1 16	15 2 12	1 3 3 8	1 12 0 4	2 0 1 0	2 8 1 24	2 16 2 20	3 4 3 16	3 13 0 12	4 1 1 8	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·67	15·34	23·01	1 2·68	1 10·35	1 18·02	1 25·69	2 5·36	2 13·03	2 20·7	3 0·37	3 8	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 92 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 2 0 16	8 4 1 4	12 6 1 20	16 8 2 8	20 10 2 24	24 12 3 12	28 15 0 0	32 17 0 16	36 19 1 4	0
10	0 8 0 24	4 10 1 12	8 12 2 0	12 14 2 16	16 16 3 4	20 18 3 20	25 1 0 8	29 3 0 24	33 5 1 12	37 7 2 0	10
20	0 16 1 20	4 18 2 8	9 0 2 24	13 2 3 12	17 5 0 0	21 7 0 16	25 9 1 4	29 11 1 20	33 13 2 8	37 15 2 24	20
30	1 4 2 16	5 6 3 4	9 8 3 20	13 11 0 8	17 13 0 24	21 15 1 12	25 17 2 0	29 19 2 16	34 1 3 4	38 3 3 20	30
40	1 12 3 12	5 15 0 0	9 17 0 16	13 19 1 4	18 1 1 20	22 3 2 8	26 5 2 24	30 7 3 12	34 10 0 0	38 12 0 16	40
50	2 1 0 8	6 3 0 24	10 5 1 12	14 7 2 0	18 9 2 16	22 11 3 4	26 13 3 20	30 16 0 8	34 18 0 24	39 0 1 12	50
60	2 9 1 4	6 11 1 20	10 13 2 8	14 15 2 24	18 17 3 12	23 0 0 0	27 2 0 16	31 4 1 4	35 6 1 20	39 8 2 8	60
70	2 17 2 0	6 19 2 16	11 1 3 4	15 3 3 20	19 6 0 8	23 8 0 24	27 10 1 12	31 12 2 0	35 14 2 16	39 16 3 4	70
80	3 5 2 24	7 7 3 12	11 10 0 0	15 12 0 16	19 14 1 4	23 16 1 20	27 18 2 8	32 0 2 24	36 2 3 12	40 5 0 0	80
90	3 13 3 20	7 16 0 8	11 18 0 24	16 0 1 12	20 2 2 0	24 4 2 16	28 6 3 4	32 8 3 20	36 11 0 8	40 13 0 24	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	41 1 1 20	82 2 3 12	123 4 1 4	164 5 2 24	205 7 0 16	246 8 2 8	287 10 0 0	328 11 1 20	369 12 3 12	410 14 1 4	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Rubber Proofing Co., T. Cooke & Sons Ltd., British Refrigerating Co., Robt. Boby Ltd., Taylor Bros., Leeds, Variable Speed Gear Ltd., Petters Ltd., and Vickers-Petters Ltd.

There are also splendid shows by William Beardmore & Co. Ltd. and Armstrong, Whitworth & Co., but space prevents us giving more attention to them this week.

THE GAS SECTION.

How gas can be utilised economically both in the home and workshop is extensively shown in the gas section. There are gas fires, water heaters, gas cookers, coppers, gas irons and incinerators to save labour at home, in hospitals, canteens and other large institutions. For modern factories there are every description of gas engine, gas furnaces and other appliances which all tend to cleanliness, greater efficiency and saving of labour. Among the many exhibitors are the Parkinson Stove Co., William Edgar, Blenheim Works, Crossley Brothers Ltd., the Thermal Syndicate Ltd., James Keith & Blackman Co. Ltd. Several South London Gas Companies also make a display of appliances which they supply to consumers, offering efficiency with economy in gas lighting, heating and cooking.

The exhibition will remain open for yet two months, and with travelling facilities and publicity greatly improved ought to be visited by thousands of people every day.

LEVER AND WEIGHT SAFETY VALVES.

By Edward Ingham.

A problem which frequently crops up in steam plant practice is that of determining the weight which must be applied to the end of the lever of a safety valve of the lever and weight type in order that the valve may blow off at any desired pressure. This problem is one which the average engineer-in-charge does not ordinarily feel competent to deal with, and the following considerations may prove useful.

In most text books on applied mechanics, a number of questions are set dealing with lever and weight safety valves, the student being asked to calculate either the weight required on the end of the lever, the size of the valve, or some other unknown quantity, having given all the remaining particulars. Such questions are easily dealt with, all that is necessary being to apply the principle of moments, or the principle of the lever as it is sometimes, though improperly, called.

Lever's Centre of Gravity.

In an actual case, however, the problem is not quite so straightforward. The engineer can obtain for himself the data required, such as the distances from the weight and the centre of the valve to the fulcrum, the weight of the valve and of the lever, etc., but he may be at a loss to know at what point the weight of the lever may be supposed to be concentrated. This point is at the centre of gravity of the lever, which centre of gravity is at the centre of length if the lever be straight and of uniform section throughout. If the lever is of bent form and not of uniform section throughout, the position of the centre of gravity can be determined with a fair degree of accuracy by balancing the lever on a knife edge.

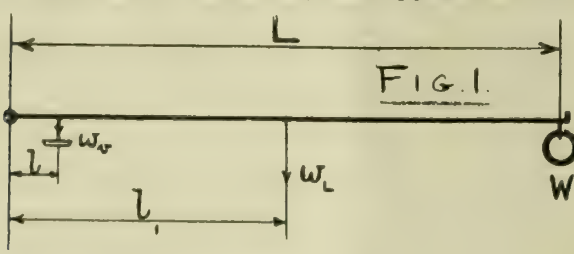


Fig. 1.

A diagrammatic sketch of the usual arrangement of a lever and weight safety valve is given in Fig. 1.

Let W = the weight, in pounds.
w_L = the weight of the lever, in pounds.
L = the distance from the weight to the fulcrum, in inches.
l_1 = the distance from the centre of gravity of the lever to the fulcrum.
= the distance from the centre of valve to the fulcrum.
w_v = the weight of the valve in pounds.
p = the steam pressure in pounds per square inch.
D = the diameter of the value in inches.

Then by the principle of moments, we have—

$$W \times L + w_L\, l_1 = \left(\frac{\pi}{4}D^2p - w_v\right)l.$$

From this equation, the value of W is easily calculated.

Sometimes, it is required to find the position of the weight, when the magnitude of the weight is already fixed. All that is necessary is to find the value of L from the given equation. In the foregoing calculation, we have taken into account the weight of the valve and the weight of the lever. Since the effect of these is comparatively small, they are often neglected, in which case the calculation is simplified, thus:—

$$W \times L = \frac{\pi}{4}D^2p \times l.$$

From this, $$W = \frac{\pi\, D^2pl}{4\,L}$$

It is important to remember, when using this formula, that all the dimensions are in inches.

When the weight of the valve and that of the lever are not taken into account, the calculated value of the weight required on the end of the lever will be more than what is actually required, and some allowance should be made for this. Experience seems to show that suitable allowance is made by assuming the effect of the lever, and the value to be equal to a pressure of about 4 lbs. to the square inch. Thus, if the weights in question are neglected, the pressure in the calculation should be taken as about 4 lbs. less than the blowing-off pressure.

Badly-fitting Valve Seats.

We have assumed in the foregoing calculation, that the area of the valve on which pressure acts is equal to the area of the valve opening. Now it is easy to see that if the valve proper is not a perfect fit on the seating, the steam will find its way under the valve, so that the pressure acts on an area which is greater than that of the opening. This is particularly the case when the bearing edge of the seating is a wide one, as it then becomes a difficult matter to keep the valve tight, and in such cases it will generally be found that the valve will blow off at a pressure considerably below that at which it would blow if the area on which the pressure acted were just equal to that of the valve opening. Hence, in cases where the bearing edge of the seating is wide, it may be advisable to make an allowance for the

fact that the steam acts on an enlarged area. Thus, after the weight has been calculated in the manner explained, the valve should be increased, but it is difficult to say by how much. If bad cases, an increase of as much as 10 per cent might not be too much. An example will make the matters clear:—

A safety valve opening is 3 in. diameter, the weight of the valve being 3 lbs. and the distance from centre of valve to fulcrum, $3\frac{1}{2}$ in. The lever weighs 10 lbs., its centre of gravity being 10 in. from the fulcrum. Find the weight which must be placed 36 in. from the fulcrum, in order that the valve will blow off at a pressure of 100 lbs. per square inch.

Let W be the weight in pounds.

Then, $$W \times 36 + 10 \times 10 = \left(\frac{4}{\pi} \times 3^2 \times 100 - 3\right) 3.5.$$

$$36\,W = (706.7 - 3)\,3.5 - 100.$$
$$W = \underline{65.7} \text{ lbs.}$$

Here the weight of the lever and the weight of the valve has been taken into account. If this is not done the pressure must be assumed to be rather less than 100 lbs. per square inch, say 96 lbs. per square inch.

Then, $$W \times 36 = \frac{\pi}{4} \times 3^2 \times 96 \times 3.5.$$

$$W = \underline{66} \text{ lbs.}$$

This result differs little from the previous one, and the calculation is simple. To weigh the valve and the lever, and obtain the position of the centre of gravity of the lever, is troublesome, and hence the simple method will be preferred by many.

If the width of the bearing edge of the valve is considerable, then for the reasons already stated, the weight as above calculated would require increasing, the amount of the increase depending upon the width of the bearing edge and the condition of the valve.

The Value of Testing.

It will be understood that no matter how carefully the above calculations are performed, there are bound to be errors of greater or less importance, so that it is unlikely the valve will blow off at exactly the desired pressure when the weight is as calculated. The only way of finding the exact weight required is by actual testing. Thus the steam pressure in the boiler should be raised until the valve blows off, and the pressure at which blowing-off commences noted by the pressure gauge. It should be borne in mind that pressure gauges are frequenaly a few pounds slow or fast in their indications, and hence the safest plan is to apply a standard pressure gauge to the boiler and read off the pressure at which the valve blows from this gauge. If the weight be found to be too large, some of the metal may be removed until the required weight is obtained. If, on the other hand, it is too small, small weights can be added until the desired result is obtained, after which a new weight may be cast, just equal to that of the combined original and the added weights.

Instead of altering the weight, in the case where the calculated weight is found to be too great, the necessary adjustment may be made by moving the weight along the lever towards the valve, but it is better to keep the weight at the end of the lever and remove some of the metal. When the weight is not at the end of the lever, it is a simple matter for the fireman to overload the valve, which he may be tempted to do if he finds difficulty in coping with the load on the engines during a temporary overload. To guard against this danger of overloading when the weight is not at the end of the lever, it is a common plan to fit a stop-pin through the lever, so that the weight cannot be moved back, or, failing this, the portion of the lever beyond the weight may be cut away.

OIL IN THE UNITED KINGDOM.

By Professor Sir JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C E.

IT will be noted by reference to the map of the world that the continent of North America produces to-day about 85 per cent of the world's output of crude oil. The United States at present produces in her own territory nearly 70 per cent of the world's oil output, while if the quantity produced by United States companies in Mexico is added, the total United States control in North America is at least 80 per cent of the world's oil supply. It will be seen, further, that the British Empire produces only about $2\frac{1}{2}$ per cent of the world's supply, or if Persia may be said to be under British influence, about $4\frac{1}{2}$ per cent of the whole.

Liquid oils may be divided into two groups :—

1. Those which occur in nature as crude liquids.
2. Those which can be obtained by distillation from shales and coals.

It is to the former group that attention is directed in this paper, although much of our future supply will probably be received from the latter group.

The following table illustrates this point more precisely :—

THE GEOLOGICAL DISTRIBUTION OF OIL IN THE CHIEF OILFIELDS ARE AS FOLLOWS :

Geological Formation.	Percentage Production.	Locality.
Tertiary	49·4	California, Gulf Coast, Mexico, and most of the British Colonies.
Upper Cretaceous	1·0	Texas, Wyoming, Colorado.
Lower "		
Jurassic		
Triassic		
Permian		
Carboniferous, Upper Devonian	41·1	England, Texas, Oklahoma, Kansas, Pennsylvania, Illinois, and the Appalachian field.
Devonian	0·4	Canada.
Silurian		
Ordovician	8·1	Lima-Indiana.
Cambrian		

Out of approximately 60 per cent of the globe's surface covered by these rocks, only an infinitesimal part has yet been thoroughly examined for petroleum products, and it must be some comfort to imagine that even if only a moiety of them are found to contain petroleum, the stores of petroleum in the world are still plentiful and only await discovery by the geological hammer and the drill.

The figures for production and consumption for 1918 were as under :—

	Production, 1918. Tons.	Consumption. Tons.
United Kingdom	250,000	5,395,000
Canada	40,000	1,717,000
Trinidad	300,000	112,000
India	1,150,000	1,292,000
Egypt	250,000	424,000
Australia	10,000 (Australia and New Zealand)	110,000
New Zealand		67,000
Sarawak	80,000	—
Total British Empire	2,080,000	9,117,000
Persia	1,500,000	
World's production	70,000,000	

The consumption and production of petroleum products in the British Empire has been approximately :—

	Consumption.	Production.
1912	4,212,000	1,421,000
1913	4,713,000	1,519,000
1914	5,467,000	1,563,000
1915	5,184,000	1,629,000
1916	6,128,000	1,655,000
1917	7,485,000	1,774,000
1918	9,117,000	2,080,000

The United Kingdom is at present a comparatively small oil producer, practically all its requirements being drawn from overseas. Until quite recently (May, 1919) production was confined to the shale deposits of Scotland, which stretch from the Forth, between Dalmeny and Blackness, southwards to Tarbrax.

These oil-bearing strata produce about 3,250,000 tons of shale annually, the average yield being from 19 to 20 gallons per ton of shale, or approximately 250,000 tons of crude oil. The output during the last eight years has been as follows :—

	Output of oil shale. Tons.	Crude oil produced. Tons.
1911	3,206,756	293,660
1912	3,284,956	294,699
1913	3,369,321	289,684
1914	3,388,869	285,464
1915	3,187,592	263,083
1916	3,102,036	247,472
1917	3,200,883	249,598
1918	3,223,076	242,501
1919	2,814,110	211,986

Deposits of shale have also been known for many years to exist along an irregular line stretching from Kimmeridge in Dorsetshire to King's Lynn in Norfolk, and on as far as Yorkshire. None of these deposits are being worked with the exception of the Norfolk area, which English Oilfields Ltd. are attempting to develop. Several seams are stated to have been proved, and the company expect to be working on a commercial scale at an early date; but progress in development of a new shale field must necessarily be slow.

Tests are in progress in North Staffordshire (Apedale and Werington), and in Scotland (West Calder and D'Arcy), while at Kelham, near Newark, a well is being sunk by Oilfields of England Ltd.

An analysis of the Hardstoft oil is as follows :—

Motor spirit	7·5	per cent.
Kerosene	39	,,
Gas oil	20	,,
Lubricating oil	30·5	,,
Paraffin wax	3	,,
Sulphur	0·26	,,
Sp. gr.	·823	

Calorific value 20,290 B.T.U.

—*Journal of the Royal Society of Arts.*

ENGINEERING NOTES FROM FAR AND NEAR.

(Specially contributed to *The Industrial Engineer.*)

By ARTHUR H. J. KEANE.

BULGARIA WANTS FUEL. Large quantities of coal are urgently wanted in this country. In 1914 the imports of coal totalled up to 213,000 tons, whereas in 1918 and 1919, not one solitary hundredweight entered the country. Local production is absolutely insufficient to cope with the home demand even approximately.

ELECTRIC RAILWAYS IN AUSTRIA. With a view to commence the electrification of the Austrian railways a Bill has been placed before the National Assembly for the erection of hydraulic power stations: (1) At Lake Spuller, in the Vorarlverg, producing 4,400 H.P.; (2) at the actual station of Ruerbach, in the Tyrol, which has so far supplied the Mittenwald Railway with power; (3) in the Stuppach Valley, at Salzburg, yielding 6,000 H.P. Other stations will also be erected later on in this district. A station will also be opened at Malnitzbach, near Ober Fellech, in Carinthia, yielding 5,900 H.P., and, finally, a small station will be opened in Upper Austria for the electrification of the Attnang Steinach line. The costs required for this work, and for the supply of rolling stock, are estimated at 3,560 million Austrian crowns.

RAILWAY DEVELOPMENT IN JAPAN.—The proposal, now under consideration for a long time, to connect Simonosaki and Moji by means of a submarine tunnel, has now been taken up by the Railway Commission. The preliminary work will last about a year, and will cost 1,800,000 yen. It is hoped that the line will be open to traffic in seven years time. The section running between Yokohama and Yokosuka will be electrified.

METALLURGY IN THE GRAND DUCHY OF LUXEMBURG.—The coal crisis has become so acute that of 48 blastfurnaces only nine are now able to keep open. The arrivals of coke are extremely irregular, so that any co-ordinated working has become practically impossible. Under these conditions a vigorous protest is being raised against the next tax levied upon exports of metallurgical products.

TIN FROM THE MALAY STATES.—A recent decree has fixed the duties to be levied on tin and tin slag, exported from the States of Perak, Selangor, Negri, Sembilan, and Pahang, as follows: 10 dols. per chara when the price of tin does not exceed 41 dols. with an increase of 50 vents for each 1 dol. after 41 dols.; for tin melted or manufactured at Pahang 10 per cent *ad valorem*. One chara is equal to three picul, or 181 kgs. 40.

PROPOSED IRRIGATION PLANT IN ASIA MINOR.—The Turkish Minister of Agriculture is now considering vast plans for irrigating enormous stretches of land in the vilayets of Adana, Mossul, and Sivas.

ENGINEERING EXHIBITION AT OLYMPIA.—The Machine Tool and Engineering Exhibition at Olympia next September will contain the most striking show of machinery in motion seen at any exhibition for years past. One firm alone is exhibiting over £50,000 worth of machinery, and altogether there will be on view at least £1,000,000 worth of the newest, finest, and most efficient metal-working machinery of modern times. To the engineer, the great attraction will be the opportunity of studying carefully all the new designs which have been produced during and since the war.

Already 209 exhibitors have booked space at Olympia, London, for the Machine Tool and Engineering Exhibition which is to be held there from the 4th to the 25th of September. The space occupied by the exhibits will be about 15 per cent more than has ever previously been let for a machinery exhibition at Olympia.

Exhibits of machine tools and small tools are confined to those firms who are members of the Machine Tool Trades Association. No goods of German or Austrian manufacture may be shown by any of the exhibitors. It is expected that the catalogue will be ready about the 1st September.

STEEL RESEARCH REPORT.—The very extended research on automobile steels which has been carried out by the Research Committee of the Institution of Automobile Engineers has now been brought to a successful conclusion, and at a meeting held on July 21st the report was finally approved. It is hoped that it will be ready for issue by about the end of August, when a further announcement in regard to price, etc., will be made. The report will contain a vast amount of information in regard to the physical properties of the 10 automobile standard steels, of which the specifications are given in British Engineering Standards Association Report, No. 75, with coloured charts showing these properties under various heat treatments, as represented by the tensile, Izod and Brinell tests. The real work has been carried out by the Executive Sub-Committee, of which Mr. A. A. Remington, was chairman up to a certain point, Mr. J. H. S. Dickenson assuming that office for the latter part of the period of research. The remainder of the members of the Sub-Committee were Messrs. Hy. Brearley, J. Wortley Fawcett, Brig.General R. K. Bagnall Wild, C.B.E., Major H. P. Philpot, and Capt. E. W. Birch. The edition will be very limited, and will be obtainable, in the first place, from the offices of the Institution of Automobile Engineers, 28, Victoria Street, London, S.W.1.

FUEL RESEARCH. Alcohol is suitable for certain classes of motor vehicles, if mixed with ether or liquid hydrocarbons, especially benzol. The recent report of the Fuel Research Board acknowledges this fact, but it goes on to say: "It is clear that so long as only raw materials are imported for home grown food stuffs, power alcohol cannot be produced on an adequate scale, and we must look for other and cheaper sources of power." In the tropical portions of the Empire there are, however, vast quantities of vegetation of rapid growth affording a practically inexhaustible source of supply of power alcohol.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(Continued from page 294.)

Polarised Light and Pyrometry.

Polarised light has become of importance in technology on account of its applications to pyrometers, and to its use in studying the effects of stress on structures, such as aeroplanes. Engineers should therefore have some knowledge of the leading principles embraced by this branch of optics.

The most practical introduction to the subject is to experiment with a tourmaline pincette, used by opticians for testing if lenses are made of quartz.

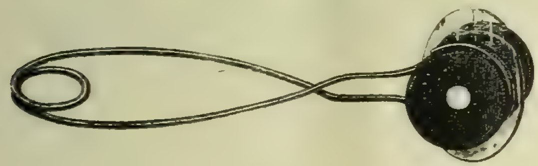


Fig. 1.

It consists (Fig. 1) of two metal discs, each having a central aperture mounted so that each disc can be independently turned about an axis passing through the centre of each hole. The discs are pressed together by the spring tong, which serves as a handle. Covering each hole is a thin slice of the gem tourmaline, a most interesting mineral on account of its optical and electrical properties. On being heated, or when submitted to pressure, it becomes electrified. It is thus both pyro-electric and piezo-electric. Tourmaline is of complicated structure, it is a boro-silicate, and may contain lithium, magnesium, iron, and chromium. In colour it may be green, blue, red, but most commonly brown. In thin slices it is semi-transparent. For optical purposes it should be cut by the lapidary parallel

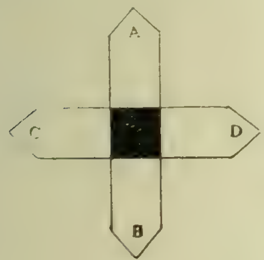


Fig. 2.

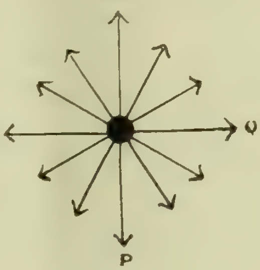


Fig. 3.

to the direction of the optical axis. On looking through the crystals at a bright light it will be noticed that the amount of light transmitted depends on their position. When they are as in Fig. 2, with the long axes at right angles, they appear opaque, but if either A or B is rotated through 90 deg., so that the axes are parallel, they are seen to be semi-transparent. If either of the plates be now rotated the light gradually fades until, when they reach the crossed position, no light is transmitted as before. The light transmitted by the back tourmaline is said to be polarised, and this is called a polariser, and the tourmaline next to the observer is known as the analyser. The apparatus is a simple type of polariscope. To use it for testing a pebble lens, the crystals are crossed and then the lens is inserted between the tongs (see Fig. 1), on now looking through the instrument if the lens be of quartz the light will now pass. This effect is called depolarisation.

Theory of Polarisation.

The above effects can be explained by the help of the wave theory of light. Let us consider what is taking place, according to this theory, when a candle is giving out light. In the flame there are countless particles which are in rapid motion of a very irregular nature. They cause the ether of space to be thrown into motion, and trains of waves are sent out in every direction. According to modern views there are in the atoms of all substances minute negatively electrified particles called electrons, held in position by a positive charge. When they are intensely heated, as in the candle flame, they become agitated and send out waves of all periods. Thus from an electron (Fig. 3) waves are sent out in the directions indicated by the arrows, only a few of the innumerable waves being shown in the diagram. It will be supposed that the wave motion, which is of the transverse kind, like the waves of the sea, is in a direction at right angles to the plane of the paper. These wave motions may be, by the laws of mechanics, resolved into two directions at right angles, such as PP and QQ. Waves in which the vibrations lie in one plane are said to be plane polarised. Now tourmaline has the special property of absorbing vibrations much more completely in one direction than in the other. With the long axis vertical, for example, it might transmit waves in the plane PP and obstruct those in the plane QQ. Hence, only waves in the direction PP are transmitted, or in other words, the first tourmaline polarises the light. When the analyser is crossed the motion is stopped, for this tourmaline can in this position only transmit motion in the QQ direction.

Use of Iceland Spar.

Tourmaline not being a very transparent substance is not suitable for making a good polariscope. Prisms of Iceland spar are very transparent and are much in use in making various types of polaris-

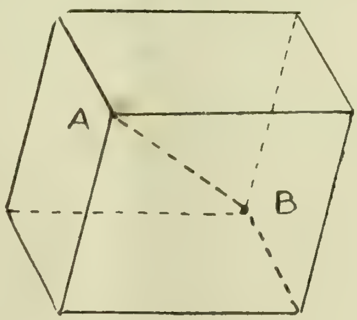


Fig. 4.

ing instruments. Iceland spar is a variety of the mineral calcite, and is nearly pure calcium carbonate. The chief source of supply has been a cave on the East Coast of Iceland, and when first discovered in the 17th century, this cave was filled with crystallised masses and crystals, some being a yard long. Large crystals are now scarce and are very costly when they are of sufficient transparency

for optical purposes. The mineral is found in a number of different types of crystals, but the working optician has no difficulty by following the lines of cleavage in always obtaining the spar in the primitive form of rhombohedra. Such a form is shown in Fig. 4. A rhombohedron is bounded by six parallelograms having two obtuse angles of 101 deg. 51 min. and two acute angles of 78 deg. 5 min. Two opposite solid angles A and B are bounded by three obtuse angles. A line drawn through A or B equally inclined to these solid angles and any other line in a parallel direction is called the optic axis of the crystal. The figure shows a simple case having equal edges when AB, or any parallel line, is the optic axis.

In 1669, Erasmus Bartholinus published a treatise dealing with a remarkable property of the spar. He found that when a crystal was used to view, say an ink spot, on paper two images were seen. This shows that the spar has the property of double refraction. A few years later Huygens explained this by the help of the wave theory, and discovered that the spar polarised light.

Nicol's Prism.

An excellent method of utilising Iceland spar for the production of polarised light was introduced about 70 years ago by William Nicol, of Edinburgh. He designed a special kind of prism, which is always known by his name. They are so invaluable as polarisers and analysers that the scarcity of suitable spar is much to be regretted, but fortunately, for most optical purposes, only prisms of small size are

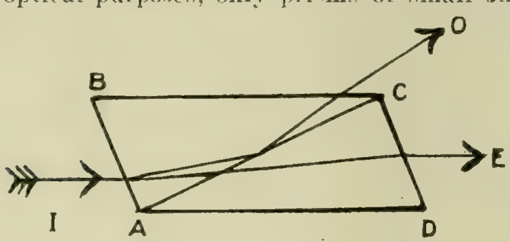


Fig. 5.

required. The method of construction and action of a Nicol's prism is shown in Fig. 5. A rhomb ABCD of Iceland spar is selected with the edges of the end faces equal and one-third the length of the other faces. It is sliced into equal parts from one obtuse angle A to the other at C; the cut faces are polished and cemented together by the use of Canada balsam. If a ray of light I impinges on the face AB it will divide into two rays, one, the "ordinary" ray, will be more refracted than the other or "extraordinary" ray; the latter will pass through the prism and escape at E. The ordinary ray, on the other hand, will be totally reflected from the film of cement and is displaced in the direction shown by the line at O; it, however, does not escape, but is absorbed by the face BC, which is covered with dead black paint. The escaping ray is polarised. For a polariscope two Nicols will be necessary, one to act as a polariser and the other as an analyser.

Rochon's Prism.

For a Wanner pyrometer, in addition to a Nicol, another type of polariser will be required. This is a double image prism designed by Rochon. In one of its forms it consists of two equal prisms of calcite, one being cut so that the refracting edge is parallel to the optic axis, as represented by the lines within ABC (Fig. 6), and the other one cut perpendicular to the optic axis, as shown by the dots within BCD. It is a property of the optical axis that a ray passing along it is not doubly refracted; accordingly the ray I normal to the face AC will not divide until it reaches the face BC where it is doubly refracted, and the ordinary ray passes out at O, whilst the extraordinary ray escapes at E. The rays are plane

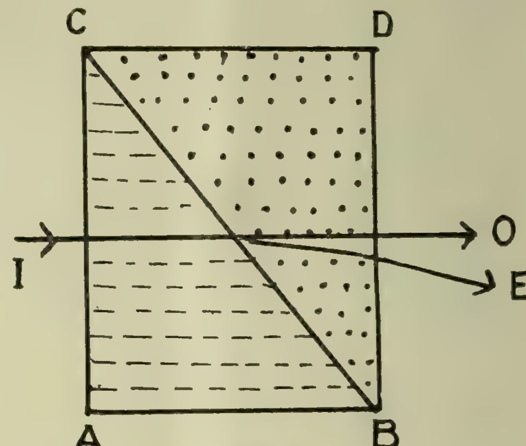


Fig. 6.

polarised in planes at right angles to each other. An interesting application of such a double image prism is for the purpose of finding the apparent diameters of the planets with accuracy.

The Biprism.

In Wanner's pyrometer another kind of double image prism is used which does not polarise light. It is made of glass with a very obtuse angle at H (see Fig. 7), and very acute angles at G and H. these only being about a degree each. When the eye is at E two images A and B are seen of the object at L.

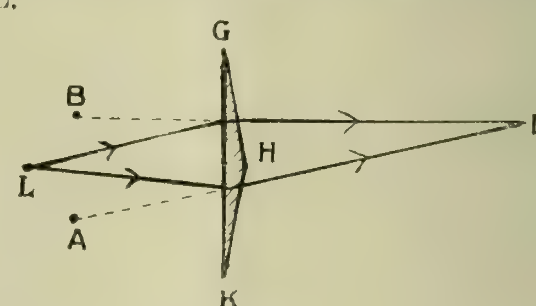


Fig. 7.

The Direct Vision Prism.

Still another type of prism enters into the construction of a Wanner pyrometer. Its object is io separate the red light from the other colours emitted from the heated source. Direct vision prisms enable spectroscopes to be constructed which can be directly pointed at the source of light to be analysed. They are very convenient for the spectrum analysis of metals, alloys, salts, etc., testing of photographic plates, the examination of dyes, the detection of blood, and for the predication of rain. The optical arrangements of a spectroscope of simple construction are seen in Fig. 8. The light to be analysed passes through a narrow slit at S, and then is made into a parallel beam by the achromatic lens

O, and then passes through the prism to the observer's eye. It will be seen that the prism really consists of three prisms, cemented together; the middle prism is of very dense flint glass, and the

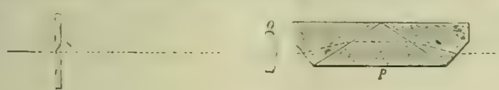


Fig. 8.

two outer ones are of crown glass. The angles of these prisms are so chosen that the middle part of the spectrum passes through without deviation, as illustrated by the ray in the diagram. The complete

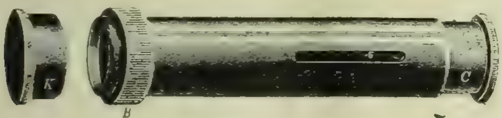


Fig. 9.

instrument is shown in Fig. 9. By turning the milled ring B the width of the slit can be adjusted and the spectrum can be sharply focussed by sliding in or out C. When not in use the slit is protected by the cap K.

(To be continued.)

GRINDING HIGH-SPEED STEEL REAMERS.

By G. A. Park.

During the past few years several very hard, dense steel alloys have been developed particularly for use in reamer blades, cutters, and tools. Probably most of the readers are familiar with the difficulties encountered in grinding these alloys, such as checking, cracking, and distortion of the steel. We shall outline briefly, however, the experience of one plant in overcoming these difficulties.

The steel in question was a high-speed tungsten alloy developed primarily to replace the Austrian "gold label" steel. It was extremely hard and dense, and very sensitive to sharp temperature changes such as might occur during grinding, if special care was not used. This steel was in the form of reamer blades 1 in. thick, to be used in large tapered double-bladed gun reamers up to 6 in. long. The grinding was a very delicate proposition and required extreme accuracy.

After the reamers had been set up, they were ground cylindrically on a Norton 14 in. by 96 in. plain grinder to the correct taper, leaving 0·020 in. of surplus stock as measured diametrically to allow for lipping the cutting edge. This lipping consisted of grinding a concaved flute along the edge of the reamer blade about ¼ in. to ⅜ in. wide and $\frac{1}{16}$ in. deep.

A portable electric grinding machine was then bolted to a steel arm protuding from the safety hood of the Norton machine, so arranged that the spindle of this portable machine was at right angles to the table traverse. Wheels 3 in. by ⅜ in. by ⅜ in., grain 3864 grade K, Alundum vitrified with a rounded face, were used on the electric grinder. An adjustable rest was inserted undereneath the reamer to hold the work absolutely rigid while this lipping operation was being carried on. It was important that the reamer blade should be in the same plane as the work centres while fluting to insure an even depth to the whole length of the flute. The electric grinding machine was fed down on to the reamer blade at the rate of approximately 0·001 in. per traverse until the flute was properly ground. If the original milled flute in the blade was very uneven, it was necessary to true the grinding wheel several times during the operation. Care must be taken to prevent burning the blades either through too deep a feed or glazing of the wheel face.

The electric grinding machine was then dismounted and the reamer finish ground cylindrically to as nearly perfect size as possible. The limits as measured diametrically were plus 0·00025, minus 0·000. There could be no measurable variation in the taper from one end to the other.

The next operation was that of backing off the blades, and here the real difficulty arose. It was done in the same Norton machine with wheels 14 in. by 1 in. by 5 in., which happened to be the only size available at the time. A number of different grains and grades were tried with every possible combination of feed, table speed, and dressing available on the machine, but the blades would invariably burn black and develop fine cracks after the table had traversed only one-half of the reamer length. This happened when grinding both wet and dry; in fact, it was found impossible to grind this material wet under any conditions. A Huntington dresser was used to open up the face of the wheel with not much better results. A feed as light at 0·00025 in. per traverse caused bad burning. The blades would develop fine cracks which would gradually open up until pieces would break off altogether. Sometimes, after burning, cracks could not be seen, but the blade would break down while being used.

The wheel face did not show any signs of loading or glazing, and it occurred to the operator that perhaps he was not really removing stock, but rather that the wheel was simply rubbing over the steel and generating the heat which caused burning. Therefore, it seemed a question of forcing the wheel to remove the material.

A fresh start was made and the wheel (Norton 3846-I vitrified) dressed with a Huntington dresser to a very coarse face. It was then fed into the work 0·002 in., and the reamer traversed by hand as rapidly as possible. The grinding was done dry. The result was very encouraging. Not a sign of burning appeared although we had taken a much heavier cut than before. The step was repeated with the same result. Apparently the problem was solved and all of the reamers were backed off in this way in a very short time and with absolutely no burning. Of course, the wheel showed some wear to each traverse, but this was negligible as lighter cuts could be taken on the final traverses of each blade to avoid the excessive wheel wear. An extremely fast table traverse was the real factor in eliminating the burning of the steel.

This company has since changed to the use of a 3824 grade H Alundum vitrified wheel for this backing off work.

The reamer blades were backed off to a very narrow land and afterwards honed. By mounting the whole finished reamer in a lathe and trying the blades at intervals with a bar of copper mounted in the tool post, the rubbing or honing of the edges to insure equal working capacity of the blades was readily accomplished.—*Grits and Grinds.*

Motor Notes.

THE BASES OF MOTOR TAXATION.

Those interested in road transport have been divided into two camps over the motor taxation proposals in the Finance Bill, and with the passing of the Act it is to be hoped that this unhappy difference in opinion may come to an end. The Bill provides for duties on private cars at the rate of £1 per horse power, cabs and goods carrying vehicles at lump sums payable quarterly (the latter on a scale based on unladen weight), and 'buses and chars-a-banc according to the number of persons carried. These imposts are to supersede the existing duty of 6d per gallon on petrol for private cars, 3d. per gallon for business vehicles, chiefly, the Government allege, because of the difficulty of thus differentiating between business and private cars.

The Government proposals are supported by a certain section of those interested in business transport, but others, together with practically the whole of the private car interest, strongly press for the retention of the petrol tax at a flat rate of 4½d. a gallon for all, in addition to a vehicle tax, graded so as equitably to distribute the burden over all classes. Machines using other fuels than petrol, they hold, can be taxed correspondingly.

A duty on fuel is the only practicable method for graduating payment according to road usage, and the justice of the principle is undeniable, but the flat rate is open to question, since it is an axiom that taxation of industry is undesirable if it can be avoided. Also, the greater the mileage, the less idle is the capital represented by the car, and the better asset it becomes to the nation; yet under a fuel tax the more efficiently transport is worked, the more it has to pay. In this matter the Government proposals at least encourage sound economic mileage.

Under the Finance Act scheme the amounts payable on the different sizes of goods carrying vehicles would be more than equivalent to the existing 3d. per gallon petrol duty over the mileages given in the table below, assuming the reasonable consumptions in the third column :—

Vehicles not exceeding (unladen). Tons.	Cwts.	Government Proposed Tax. £	Reasonable Consumption. M.P.G.	Mileage at 3d. a gal. that would produce same sum as proposed tax.
0	12	10	18	14,400
1	0	16	13	16,640
2	0	21	11	18,480
3	0	25	8	16,000
4	0	28	6	12,440
Exceeding 4 tons		30	4½	10,800

Those commercial automobile interests that oppose Government proposals and advocate a 4½d. per gallon flat rate on petrol with a modified vehicle tax, evidently base their argument on the assumption that business cars average only little, if any, more than 50 per cent of these mileages, and as their objection is undoubtedly based on knowledge, it is fairly certain that business vehicles as a whole are not being worked as efficiently as they should be, even allowing for a large proportion of uneconomic load handling and other delays.

As an encouragement to effective annual mileage, the Government tax ought to have a healthy effect. Its objections are that though it can be paid quarterly (with an addition of 33 per cent), it involves a considerable lump sum, which may come hard on the small man; also for those chassis used part of the year for passenger carrying and the rest for goods, payment by hard and fast quarters may involve having to choose between paying a quarter's taxation at the far higher passenger rate for only two or three weeks of passenger work, or losing passenger trade, and here again it is the small man that is affected.

WATCH THE SIX-WHEELER.

Even at the moment transport workers are pressing for another 25s. a week, and with the ever-increasing wage bill the need for moving a maximum of load with the minimum of labour becomes more and more insistent. For this reason, the development of the six wheeler, at present in progress, should be carefully watched, for departure from the conventional four-wheeled road vehicle offers the only means of increasing load.

This idea has been considerably used in America, but little in the British Isles The only six wheeler at present tried out in this country is the Scammell, which has just completed a working tour of some 5,000 miles during which it was put to some very severe tests. It is not surprising that in such a trial of the first machine of its sort certain minor detail modifications and improvements should have been shown desirable : if such were not the case, tests like these would lose their meaning. Nevertheless, as a whole the machine promises exceedingly well, especially for working under such conditions as, for instance, exist at the docks. Without exceeding the 6-ton axle weight limit for cars allowed to travel 12 miles an hour under the Heavy Motor Car Order, the six-wheeler can carry 7½ tons of useful load as against the 3½ tons, which is about the biggest useful load that can legally travel at 12 miles an hour on the ordinary vehicle, or the 5 tons which is the maximum at 8 miles an hour.

HEAVY TRANSPORT ON PNEUMATIC TYRES.

The six-wheeled Scammell trailer has hitherto been fitted with solid rubber tyres, but it is proposed to try the machine with the giant pneumatic that are rapidly finding increased adoption in this country, where already well over 320 heavy cars are fitted with them. This move, too, is one to watch closely, for it holds vast possibilities.

Transportation is a matter of load and speed. Both are restricted by law because of the possible road damage either might cause in conjunction with the other. With soft pneumatic tyres, however, both these damage possibilities are much reduced, especially on the tar-bound road surfaces which are becoming general. Added to this the greater resilience of carriage enables the chassis to be built lighter, and this again reacts on the road : in Italy some remarkable light chassis of 2-ton load capacity have been built solely for work on pneumatic tyres.

With such a prospect then would it be unreasonable to hope for a speed limit increase from 12 to 18 or 20 miles an hour? Heavy cars running on pneumatics at the increased speeds would do far less damage than solid tyres at the now permitted 12 miles an hour. Fifty per cent increase in the use of our road transport with a decrease of road wear is well worth considering.

ROAD TRANSPORT DEVELOPING IN HOLLAND.

At the time of the armistice 25 motor lorries were in use in Holland. Now there are over 1,500, and the number is still rapidly increasing. The Dutch road authorities are giving much attention to motor transport which will form a very prominent feature in the Roads Congress Exhibition to be held at Scheveningen in mid September next. Incidentally, the Dutch have a strong preference for British vehicles.

BRITISH-PRODUCED OIL RESULTS.

In reference to home-produced fuel it was recently announced that up to the end of July the Hardstoft boring in Derbyshire had yielded 116,000 gallons of crude oil, and was now producing a ton a day, which presumably may be put at about the equivalent of 260 to 300 gallons.

A WIDESPREAD SELLING AND REPAIR DEVELOPMENT.

Working cost bears such a large proportion to the actual price of a vehicle that a recently-announced development in Surrey is deserving of particular attention.

The underlying idea is to distribute all over the county depots for selling and repair work, so that an improved and uniform system of service shall be available to customers not only in their own home neighbourhoods, but wherever they travel in the county. Nor is this development limited to a single county. Already a similar organisation is being formed in Sussex, and if these are successful the intention is similarly to cover London and all the home counties as the next step. Thus, it is pretty obvious that the country may be threatened with a sort of ring in motor agency and repairing, and this is the more likely, in that the promoters are as far as possible avoiding the development of new businesses, preferring to co-operate with, or absorbing, existing undertakings. In so far as efficiency is increased by doing things on a big scale with better organisation than the small man is likely to possess, such a development would be an unquestionable advantage; it would tend to better value for money if it did not lower prices. But once such an organisation had completed its ring, what guarantee would the public have that prices would not be raised?

Electrical Research Association. Application is being made to the Board of Trade for a licence by the British Electrical and Allied Industries Association. The object in establishing the Association is to promote research and other scientific work in connection with electrical and allied trades, and for that purpose to set up laboratories, workshops, factories, etc., for experiments. Funds are to be provided for these works, and for the payment of persons employed, and also for the education of persons likely to become connected with the industries, by means of schools, colleges, scholarships, etc.

Trade Items, Notes, &c.

Over 300 iron firms in Germany have amalgamated in an association for pushing business.

Ford Car Prices Drop.—Ford motor cars have been reduced in price in this country as follows: One-ton truck to £230 from £280; delivery van, to £255, £230 from £255; five-seater touring car, to £250 from £275.

The South African Association of British Manufacturers and Agents was formed on December 4th, 1919, for the purpose of protecting British trade interests in South Africa. Arrangements have been made for two of its members to serve with the British Engineering Standards Association.

Wages Advance.—A conference of the Lincolnshire Ironmasters' Association, Electrical Trades Union, Amalgamated Engineers' Union, and Associated Blacksmiths and Boilersmiths, held at Doncaster, decided to accept an offer of an advance which will raise their wages from £4 11s. 8d. to £5 12s. 10d. per week.

Sharp Fall in Freights.—For a period of six months a large steamer has just been chartered at 14s. 6d. per ton. In December last 40s. was the charge made on an 11.000 tons steamer. To-day, it is impossible to get 17s. 6d. for it. Another steamer of 5.000 tons stood at 38s. in December, and the owners would now gladly accept 17s. 6d.

Another Wage Claim Rejected.—The National Union of Railwaymen applied for an increase of 6d. an hour on pre-war rate, plus the recent 6s. advance, the 33s. 6d. a week, and the 12½ per cent war wage for men employed in railway companies' electrical power and sub-stations. The claim has not been approved by the Industrial Court.

Messrs. Sterns Ltd., Royal London House, Finsbury Square, London, E.C.2, inform us that they have been able to obtain a satisfactory raw material to turn out a ball-bearing grease, which they claim is of a very superior type. This particular grease has a high melting-point; it is claimed to be free from all moisture, acid, or impurities. Samples of this particular grease will be forwarded by Messrs. Sterns on request.

Suggested Wages Truce.—One of the most valuable suggestions at the recent Engineers' Industrial Court was made by Mr. Saxon J. Payne, on behalf of Messrs. Harland & Wolff, of Belfast and the Clyde. It was that present rates of wages should be stabilised for two years. If this were agreed to by the employers it is believed that the workers would accept the recent award, and abide by the two years' truce.

Railway Dividends.—The directors of the Great Eastern Railway Company have declared an interim dividend of 10s. per cent on the ordinary stock for the first half of the year. The return for the full year 1919 was 2⅜ per cent, as compared with 2¼ per cent for each of six preceding years. The North Staffordshire Railway Co. also declared its interim dividend in July. The rate is 1⅞ per cent actual, as it was last year and in 1918. For each of the last two full years 5 per cent was paid.

Launch with Steam Up.—The War Iliad, built by the Monmouthshire Shipbuilding Co., Chepstow, to the order of the Ministry of Shipping, was launched on July 17th, with steam up, and proceeded at once on her trials. She was handed over to the owners on the same day. This constitutes a record. Some weeks are usually occupied in fitting up and engining a ship after she is launched, following which the trials have to take place. The War Iliad is 411 ft. long, and 10,000 tons dead weight.

Sheffield Trade and High Wages.—A memorandum which has just been issued by the Sheffield Chamber of Commerce says that within the last six months Sheffield has lost to America and other competitors contracts worth hundreds of thousands of pounds. Manufacturers have been unable to give firm quotations owing to repeated wage advances. The practice has become general of demanding immediate advances, and in some cases advances have been made retrospective. It is suggested that a reasonable time should be mutually fixed upon between employers and labour before any increases in wages become operative.

Harland & Wolff to Work in London.—It is announced that Messrs. Harland & Wolff have decided to erect repairing shops in various London docks, and undertake general ship repairing work in the Port. They are also negotiating with the Port of London Authority for the whole of that Authority's engineering repairing work over a long period. The intention is that the management of the Authority's repairing shops will be taken over by the firm. Messrs. Harland & Wolff employ at Belfast some 21,000 men, and the weekly wage bill is £80,000. The firm has also works on the Clyde, and ship repairing and engineering shops at Southampton and Liverpool. Altogether they employ 50,000 men, and pay upwards of £200,000 per week in wages.

There are many articles of interest to engineers now being shown at the quarterly display of French manufactured goods in the offices of the French Commercial Intelligence Department at 53, Queen Victoria Street, London, E.C.4. Among the exhibits are registering instruments for scientific and industrial purposes, tenoners and groovers, and a dove-tailing machine producing 60,000 tails a day, and medical and surgical apparatus. Testing and measuring machines are also on view, and a metal milling cutter said to have three times more efficiency and output than the best helicoidal milling cutters. The exhibition remains open to the end of this month, and the "office" has means of providing French exporters with agents residing in the United Kingdom who possess knowledge of the class of business to be developed.

Concrete Ships: Experience of First British Boat.—With regard to criticisms of concrete ships it is pointed out by a technical authority that the cost of building is naturally heavy in the present inflated state of the market for both materials and labour, but the same may be said of steel shipbuilding. The experience of the United States Shipping Board proved the cost of concrete steamships at war rates to be from 20 to 40 per cent less than the cost of all-steel steamships built during the same period. Further, the designers erred on the safe side, leaving economies to be effected when shown to be justified by actual experience. With regard to economy of operation, the United States Shipping Board state that the ratio of the deadweight capacity to total displacement for the lightest concrete ship so far constructed is 0·56, this being about the same as for a wooden ship, but much less than for an all-steel vessel. As to the behaviour of concrete ships in actual service, the experience of Messrs. Leopold Walford (London) Ltd. during over 12 months' operation of the s.s. "Armistice," the first British built ferro concrete steamship, is interesting. She has been run under their direction from her first trip in March, 1919, to the present date. They say the "Armistice" has been running like a clock, causing no trouble, disappointment, delay, or difficulty. She has carried coal, minerals and general cargo in all kinds of weather, and on an early trip carried some 900 tons of oats, or about 200 tons more than could have been accommodated in a steel ship of equal deadweight capacity. She has encountered severe gales and heavy seas, proving thoroughly seaworthy, and the captain, officers, and crew say they could not wish for a more comfortable boat. Although the hull was not painted or treated with anti-fouling composition, it is perfectly clean after over 12 months' service. There is low frictional resistance of ferro-concrete hulls to passage through the water, and the "Armistice" does not require more coal than would be wanted for a steel ship of equal capacity. On the score of upkeep the daily cost per ton deadweight of the "Armistice" has been only one-fifth the average cost for steel vessels working under similar conditions. Only two mishaps have occurred during the past year. On one occasion the ship grounded on a soft bottom, and was got off without showing any trace of damage, and on another occasion the bow of a lighter punched a small hole in the stern deck-house, the sides of which are quite thin. If the lighter had collided with the body of the hull no damage would have resulted. The collision occurred in London, and the "Armistice" was due to leave the next morning. All ship repairers were then out on strike. The damage was made good by a small quantity of cement mortar placed by the aid of boards inside and outside the deck-house by the staff of the boat, and she was ready to sail at the appointed time.—*South Wales News.*

Foreign Notes.

The Melbourne Wages Dispute.—A conference of employers and employees has fixed the basic wage of enginemen at 13s. 6d. a day.—Reuter.

Heating Apparatus Manufactory at Bilbao. Negotiations are proceeding at Bilbao relative to the establishment of a heating apparatus manufactory in that town. Reuter.

Coal and Coke Freightage to Swedish Ports.—Freights from England stand at about Kr.35 for coal, and about Kr.45 for coke. Higher freights are being paid for smaller tonnage.—Reuter.

New Spanish Line: Tenders Invited.—An adjudication for the construction of the branch line from Zumárraga to Zumaya (Province of Guipúzcoa) will take place on September 20th. The Compañia de Ferrocarrilles Vascongados has the right of pre-emption. - Reuter.

Brussels Iron Market.—This iron market is favourable generally. There is a fairly good demand for pig iron. The bar market is not quite so firm. Iron wire is in demand. The latest quotations are: Pig iron, Fr.60 to Fr.65.; bar iron, Fr.115; iron wire, Fr.120 to Fr.125.—Reuter.

Victorian State Rivers and Water Supply Commission: Tenders Invited for Steam Turbines.—Tenders are invited up to October 20th by the Victorian State Rivers and Water Supply Commission for the manufacture and supply of two 1,600 B.H.P. steam turbines, with mechanical reduction gearing and condensing plant. -Reuter.

Pumping Plant Wanted.—The Department of Overseas Trade informs us that two Diesel oil engines (best type made) capable of driving with helical gear a set of treble ram pumps against a head of 350 ft., and delivering 2,000,000 gallons of water per day of 24 hours, are wanted by the Port of Spain City Council, Trinidad, British West Indies.

American Steel for German Shipbuilding Industry.—It is understood that representatives of German shipbuilding interests have recently placed orders in the United States for steel amounting to 31,000 tons, while it is believed that an additional 34,000 tons will be contracted for as soon as the Germans can make proper financial arrangements.—Reuter.

Catalogues for Riga.—It is intended to establish at Riga a collection of British catalogues and trade journals for inspection by callers and distribution among local traders, and firms are invited to forward catalogues or other trade literature for inclusion in the collection. The Department of Overseas Trade will furnish any further particulars desired

U.S. Steel Mills to Burn Oil.—Five thousand men are idle at Gary, Ind., as a result of the fuel shortage. The big Bessemers in the works were operating only intermittently, the plant being seriously crippled. Twelve of the big blast furnaces were cold. It was announced that, in order to continue partial operation, the Gary works will hereafter use oil as fuel in many departments. Reuter.

Messrs. Vickers and Australian Shipyards.—In the Commonwealth House of Representatives, on July 21st, Sir Joseph Cook, Minister for the Navy, referring to rumours that Messrs. Vickers were trying to purchase shipyards in Australia, said that it would be the best bit of business possible for Australia if the Government could induce a firm like Vickers to establish itself in Australia. Reuter.

Electrical Installations in Spain.—It is estimated by a competent electrical engineer that the electrical installations in course of construction in Spain will have a force of 250,000 H.P. Active investigations are being made in the valley of Aran (Province of Lerida) relative to the possibility of utilising existing falls in that region, and forming new ones. The force already in exploitation is calculated at 600,000 H.P. Reuter.

Woodworking Machinery from Sweden to Soviet Russia.—The Soviet Government's representative Dr. Lomonosov, who is at present in Sweden, has entered into an agreement with Beronius Mekaniska Verkstads Aktiebolag (Beronius Mechanical Works), Eskilstuna, whereby the latter undertakes to deliver large parcels of woodworking machinery to Russia.—Reuter.

Importation of Gasoline into Spain.—The agricultural and other industries in Spain are urging that gasoline should be exempted from Customs duties on importation. The Minister of Finance does not deny the reasonableness of the demand, but he asks for safeguards against the use of the free gasoline for other purposes, such as, for example, for running pleasure cars. It is hardly thought likely that the petition will meet with success.—Reuter.

Mecanique-Automobile-Somea.—The objects of the Mecanique-Automobile-Somea, Brussels, are to carry out all industrial enterprises in connection with machinery, and more especially the manufacture and sale of all kinds of motors and automobile vehicles. The capital of 1,000,000 francs is divided into 5,000 shares of 200 francs each, subscribed and fully paid up. In addition, there are 7,500 dividend shares without nominal value which are to be distributed among subscribers of ordinary shares.—Reuter.

Tenders Wanted.—Catalogues from British manufacturers descriptive of the following appliances are wanted by a Sydney, N.S.W., firm, which is building a large factory for the production of live-stock goods: (1) Oil presses, hydraulic type; (2) Oil expellers, cone and screw type; (3) Cakette machines; (4) Grinding machines for fine grinding of grain, fibrous material, and shell breaking for poultry grit. The name and address of the firm and other particulars may be obtained on application to the Overseas Department, Board of Trade.

American Steel, Engineering, and Automotive Products Company.—An independent branch of the American Steel, Engineering, and Automotive Products Co. of Berlin has been established at Hamburg under the name "Amstea." The new company, which has a capital of Mk.1,000,000, has been formed for the purpose of supplying German shipyards with American shipbuilding steel. The *Vossische Zeitung* reports that the Amstea has already entered into contracts for the delivery of considerable quantities of American steel for Blohm und Voss.—Reuter.

Japanese Government Subsidises Iron Industry.—The Japanese Government has decided that advances will be made to iron mills through the Bank of Japan at the rate of 10,000,000 yen each. There are five of the mills thus protected: The Tanaka Mining Co., the Hokkaido Iron Mill, the Toyo Seitetsu Kaisha, the Mitsubishi Steel Works of Kenjiho, and Penchifu Iron and Colliery Co. No other iron mills are to be given this relief. This protective measure is adopted as the result of repeated petitions made to the Government on the ground that the present crisis has reduced the price of pig iron below the production cost, while the stock on hand has ceased to sell. The accumulated stock of pig iron will be disposed of by effecting dumping in the Eastern countries where iron is wanted. Reuter.

American Machine Company News.—The Duriron Castings Co., 80, West Street, New York, manufacturers of acid and rust-proof iron products, etc., has increased its capital to 600,000 dols. The H. S. Fitzgibbon Co., Inc., Sea Cliff, L.I., has been incorporated with a capital of 300,000 dols. to manufacture power plant specialities. The Rector Carburettor Co., of New York, has been incorporated with an active capital of 215,000 dols. to manufacture ignition equipment. The Reed Wire Specialities Corporation, New York, has been incorporated with a capital of 500,000 dols. to manufacture wire products. Messrs. J. H. Bunnell & Co., 32, Park Place, New York, manufacturers of electrical specialities, has increased its capital from 150,000 to 300,000 dols. The Broadway Auto Radiator and Electro Plating Co. New York, has been incorporated with a capital of 15,000 dols. to manufacture automobile radiators, and other sheet metal products. The Endurance Battery Corporation, Plainfield, N.J., has been incorporated in Delaware, with a capital of 10,000,000 dols., to manufacture electric storage batteries. Reuter.

New Companies.

A. & R. Brown Ltd. Private company. Registered August 6th. Capital, £125,000 in £1 shares. To take over the business carried on at Liverpool as "A. and R. Brown," to carry on the business of founders, mechanical engineers, blacksmiths, boiler-makers, tinsmiths, tool makers, metal workers, machinists, joiners, builders, ship repairers, electrical and water supply engineers, etc. The first directors are to be appointed by the subscribers. Solicitor: T. M. Harbottle, 22, Great St. Helens, E.C.

P. Pike & Co. Ltd. Private company. Registered August 6th. Capital, £10.000 in £1 shares. To take over the business of motor engineers carried on by P. Pike, E. Wood and J. Eddy at Alphington Street, Exeter, as "P. Pike and Co." Permanent directors: P. Pike, E. Wood, J. Eddy, and F. J. C. Hunter. Secretary: E. Wood. Registered office: The Garage, Alphington Street, St. Thomas, Exeter.

Nail Making Machines Ltd. Private company. Registered August 3rd. Capital, £25,000 in 21,200 preference shares of £1 each and 76,000 ordinary shares of 1s. each. To acquire and turn to account any inventions relating to the manufacture of nails and to adopt agreements with F. Humphris, K. A. Roberts, British Horse Shoe Nail Ltd., and the Painless Horse Shoe Nail Ltd. The first directors are F. Humphris, K. A. Roberts and J. H. Oldfield. Registered office: 24, Pall Mall, S.W.

County of Durham Foundry Co. Ltd. Private company. Registered August 5th. Capital, £14,000 in £1 shares. To carry on the business of ironmasters, steel makers and converters, founders, tinplate makers, etc. The first directors are C. F. Bacon, R. P. Forster and C. Forster. Registered office: Idsley House, Spennymoor.

Joseph Maina Ltd. Private company. Registered July 31st. Capital, £5,000 in £1 shares. Civil, mechanical and electrical engineers, etc. Permanent directors: J. M. Main, J. Maina, H. P. King and A. J. Main. Office: 65a, Holborn Viaduct, E.C.

Charterhouse Works Ltd. Private company. Registered July 30th. Capital, £30,000 in £1 shares. To take over the business carried on by W. P. McCarthy at Charterhouse Works, Coventry, as "Guest & Co.," to carry on the business of general, mechanical and electrical engineers, metal stampers and forgers, machine and engineering tool makers, etc. First director: W. P. McCarthy. Solicitor: H. W. S. Grimes, Brackendene, Burley Road, Coventry.

Bell's Asbestos Eastern Agency Ltd. Registered July 30th. Capital, £43,020 in £1 shares. To take over all or any of the undertaking and assets of Bell's Asbestos Eastern Agency Ltd. (incorporated in 1894), and to carry on the business of dealers in asbestos goods and goods connected with the utilisation thereof, etc. The first directors are A. G. Angier, H. R. Preston, E. C. Lane, G. W. Giles and T. Thomas. Minimum cash subscription, seven shares. Registered office: 34, Fenchurch Street, E.C.

Joseph Bolton & Co. Ltd. Private company. Registered in Edinburgh July 30th. Capital, £5,000 in £1 shares. Rubber and asbestos merchants, makers of and dealers in rubber and asbestos articles, etc. The first directors are J. Bolton and Margaret Brady. Solicitor: John J. Boyd Gilmour, 19, Glasgow Street, Ardrossan.

A Wills & Sons Ltd. Private company. Registered July 31st. Capital, £15,000 in £1 shares. To take over the business of builders, contractors, water engineers and general contractors, carried on by A. W. Wills, C. C. Wills and F. J. Wills at Bath and elsewhere as "A. Wills & Sons." The first directors are A. W. Wills, C. C. Wills and F. J. Wills. Secretary: F. J. Wills. Registered office: 15, Argyle Street, Bath.

Punch Forgers Ltd. Private company. Registered August 3rd. Capital, £1,000 in £1 shares. To carry on the business of punch and general metal forgers, tool makers, founders, makers of sulphuric, hydrochloric and other acids, etc. The first directors are G. A. Pryor, J. H. Lawson, W. Davidson, A. Pasley and F. W. Bramall. Secretary: H. B. Pasley. Registered office: Punch Forge, Rockingham Lane, Sheffield.

Wilsons & Langley Ltd. Private company. Registered August 3rd. Capital, £20,000 in £1 shares. To adopt an agreement with L. Van Oppen, to develop the business recently carried on by Wilsons & Berry Ltd., referred to therein, and to carry on the business of manufacturers of engines, aeroplanes, motor cars, motor bodies, motor and other cycles and scooters, founders, mechanical or electrical engineers, manufacturers of rubber tyres and goods, etc. The permanent directors are L. Van Oppen and G. Langley. Solicitor: E. A. Clifford, Dock House, Billiter Street, E.C.

Mortgages, Charges, Satisfactions.

Tuke & Bell Ltd. Particulars of £6,500 debentures, authorised June 24th, 1920, whole amount issued. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Verity's Ltd.—Satisfaction in full on July 16th, 1920, of mortgage dated June 26th, 1917, securing £3,850.

Ryner Wilson Ltd. Issue on June 30th of £2,000, and on July 21st, 1920, of £2,500 debentures, part of a series.

Alliance Button Co. Ltd.—Debentures dated July 12th, 1920, to secure all moneys due or to become due from company to Barclay's Bank Ltd., not exceeding £5,000 charged on the company's undertaking and property, present and future, including uncalled capital.

Astin & Barker Ltd.—Mortgage dated July 6th, 1920, to secure all moneys due or to become due from the company to Manchester andd Liverpool District Banking Co. Ltd., charged on the company's undertaking and property, present and future, including uncalled capital.

Dyer & Jarvis Ltd.—Mortgage dated July 14th, 1920, to secure £5,000 charged on 60, Newman Street, and 18 and 20, Berners Mews, W., and charge on 61 and 62, Newman Street, W., of even date to secure £4,000. Holder: H. Noel, Wood View, Buckfastleigh, Devon.

Wilde & Daber Ltd.—First debenture dated July 20th, 1920, of £3,250, debentures charged on the company's undertaking and property, present and future, including uncalled capital. Holders: W. J. Kirsop, 1, Trafford Road, Salford, and F. W. Ingall, 4, Bartholomew Lane, E.C.

Robinson Bros. (Carlisle) Ltd.—Bond and disposition in security, dated July 14th, 1920, to secure all money due or to become due from the company to London Joint City and Midland Bank Ltd., not exceeding £5,000, charged on certain property in Carlisle

James Gray & Co. (Camberwell) Ltd.—Particulars of £1,000 and £1,000 second debentures authorised June 25th 1920. Whole amount issued. Property charged: The company's property, present and future, including uncalled capital. No trustees.

G. E. Adams & Co. Ltd.—Particulars of £5,000 debentures authorised July 9th, 1920, whole amount issued, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees.

Patent Applications.

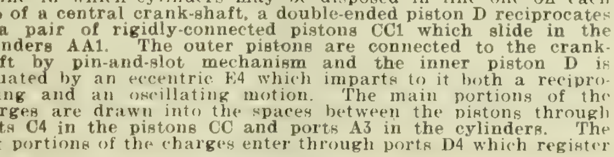
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

131,631.—T. L. DAVIES, 1, Jewin Crescent, London, and E. W. BOWEN, Denham Lodge, Walton-on-Thames, Surrey.—June 24th, 1918.—In an engine in which cylinders may be disposed in line one on each side of a central crank-shaft, a double-ended piston D reciprocates in a pair of rigidly-connected pistons CC1 which slide in the cylinders AA1. The outer pistons are connected to the crank-shaft by pin-and-slot mechanism and the inner piston D is actuated by an eccentric E4 which imparts to it both a reciprocating and an oscillating motion. The main portions of the charges are drawn into the spaces between the pistons through ports C4 in the pistons CC and ports A3 in the cylinders. The first portions of the charges enter through ports D4 which register

FIG. 1.

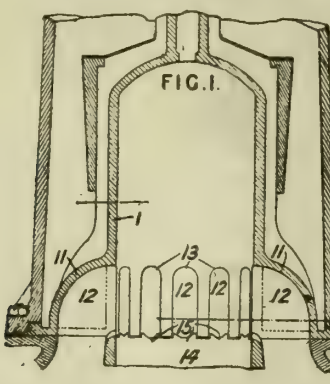


with ports C4. After compression, the charges are transferred to the combustion spaces through ports C10 in the outer pistons and passages A4 in the cylinders. A2 are the exhaust ports. According to a modified construction, the pin-and slot mechanism shown in Fig. 1 is replaced by a crank-arm pivoted to the crank shaft and carrying a pin which engages the pistons CC1 at one side thereof to impart to them a combined oscillating and reciprocating movement similar to that received by the piston D.

In a further modification, the outer pistons are open at their combustion-chamber ends and closed to form pump spaces at their ends adjacent the crank-shaft. The inner pistons are connected by pin-and-slot mechanism to the crank-shaft which carries an eccentric for reciprocating and oscillating the outer pistons. According to the Provisional Specification, the cylinders may be arranged radially.

INTERNAL-COMBUSTION ENGINES.

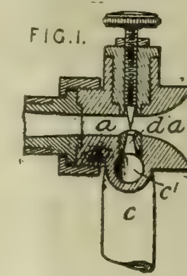
131,694.—W. J. STILL, 7, Prince's Street, Westminster.—Sept. 6th, 1917.—The exhaust ports 13 are in the form of arched or hooded openings formed at a junction of the two parts 1 and 14



of the cylinder barrel. The bridges between the ports fit notches between teeth 15 on the part 14 and the upper wall 11 of the passage 12 is in contact with the cooling-water. Specification 25356/10 is referred to

INTERNAL-COMBUSTION ENGINES.

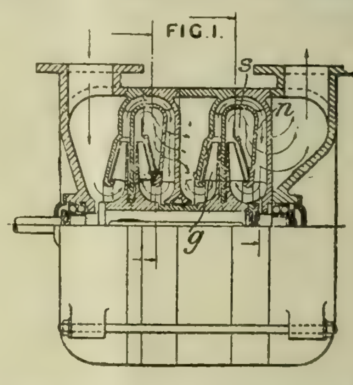
131,677.—A. COX, Harlech, Warwick Road, Olton, near Birmingham.—July 31st, 1918.—The flow of fuel from the nozzle of a spray carburettor for aeroplanes and the like in which tilting occurs, is controlled by varying the pressures on the delivery and the fuel inlet sides of the discharge orifice. This is effected by placing the nozzle *d* so that its delivery orifice is situated at the throat of a Venturi air passage *a*, and its inlet aperture at the throat *c*1 of a Venturi portion of the fuel passage *c* in which the fuel is circulated by a force feed system. The passage *a* may be the main air passage on a branch passage as described in Specification 124,061. The arrangement ensures a constant supply of fuel under all degrees of inclination of the carburettor due, *e.g.*, to climbing, diving, etc., of the aeroplane or the like. To avoid the possibility of back pressure at the fuel Venturi due



to tilting two pumps may be employed, one to force the fuel into the conduit *c* and the other to withdraw it therefrom.

CENTRIFUGAL PUMPS.

131,781.—W. J. FRAME, Southfield, Uddingston, near Glasgow.—Oct. 18th, 1918.—In a multi-stage pump of the "back-to-back" type, the discharge passage from the second stage crosses the inwardly-turned portion *n* of the channel from the discharge of the first



stage *g*. The passages are suitably shaped so as not to obstruct the inward flow of the fluid to the second stage and the rear wall of each channel projects into the annular space *s* and assists in guiding the discharge from the second stage.

INDEX TO ADVERTISERS.

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All communications intended for insertion in the INDUSTRIAL ENGINEER, *or relating to Editorial matters, should be sent addressed to "The Editors," at our Office,* 121, *DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

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CONTENTS.

EDITORIAL.

The strike of compositors in Manchester prevented the publication of the *Industrial Engineer* on September 8, and we are now publishing this issue and September 22 in one number. We regret that the descriptive article on the Machine Tool Exhibition is late in appearing, but publish it as a record.

STRIKES AND MORE STRIKES.

The Penistone strike is over. The Electrical Trade Union are satisfied that the condition of the settlement do not imply a sacrifice of the principle involved, but it is rather difficult for the outsider to understand what it profited them. The electricians at these works came out to force a foreman to join the union, and now they are back at work and the foreman is still outside the Union. There are other strikes in the engineering industry in different parts of the country, and the deplorable thing is that no sooner is peace achieved in one quarter, than trouble breaks out somewhere else. At the time of writing there is grave apprehension that there will be a national miners' strike.

Effect of a Miners' Strike.

We do not propose to labour the rights or wrongs of the miners' case here. That has been sufficiently canvassed in the daily press. No one, however, realises more than the engineer, what a stoppage of the miners would actually mean. The whole metal industry would almost immediately come to a standstill. Nothing could obviate widespread misery, and it is impossible to exaggerate it. The miners have shown a sweet reasonableness in dropping the 14s. 2d. reduction demand, and we fervently hope that they will show the same conciliatory spirit in other conferences before the fateful week is over.

Strikes and Prices.

The unfortunate thing is that a strike will not help the miner at all. If they could win—and we do not believe that could be—they would find that their real wages were lower than before. The nation needs steady and conscientious endeavour on the part of all classes of the community. These and these alone can lower prices. Even the threat of a strike by a large body of men employed in a "key" industry is unstabilising. Until the relation between capital and labour become more harmonious, and until the efforts of both are concentrated on increasing production, prices will remain high.

A Truce.

How can a permanent peace be secured or even a peace for a considerable period. The Industrial Council seems the only way out, but the Industrial Council is valueless if any section is disloyal to the main body. There has been much talk lately about the need for a "Truce of God" between Great Britain and Ireland. One would be glad to see this idea developed in the industrial field, so that for a period of two or three years there would be a guarantee of industrial peace. This would enable the leaders of industry to quote freely in the world's markets, and it would certainly result in securing many orders abroad which are frequently being lost to us.

UNEMPLOYMENT INSURANCE ACT, 1920.

The new Unemployment Insurance Act which comes into operation on November 8th next, will, with a few exceptions, extend insurance to all persons who come under Health Insurance, and employees may be expected if not subject to dismissal and their conditions of employment make insurance unnecessary. Workpeople over 70 will be insurable, except Old Age Pensioners.

Including non-manual workers in receipt of wages not over £250 a year, about eight millions will be insured under the new scheme, and four millions under special schemes set up by industries which contract out of the general scheme.

The scheme provides for a weekly contribution at the following rates: —

	Employer.	Employee.	Total.
Men of 18 and over	4d.	4d.	8d.
Women of 18 and over	3½d.	3d.	6½d.
Boys of 16 and under 18 ...	2d.	2d.	4d.
Girls of 16 and under 18 ...	2d.	1½d.	3½d.

The employer will affix unemployment insurance stamps to books issued by the Labour Exchanges to employed persons. The books will be for a period, November 8, 1920, to July 3, 1921. For every contribution paid in respect of men and women the State will contribute 2d. and 1⅝d. respectively, and proportionate amounts for boys and girls. Those now insured will not require new books, and their previous contributions will count under the new Act.

Unemployment benefit will be 15s. per week for men and 12s. for women. Those under 18 get half the full amount. After three days "waiting" benefit is payable for 15 weeks in any year, provided the benefit drawn does not exceed one week for every six contributions. For the first year benefit up to eight weeks may be claimed when four contributions have been paid. A contributor whose claim is disallowed may appeal to a Court of Referees, and higher to the Umpire appointed by the Crown.

An association with an unemployment fund, and a system for obtaining situations, may, subject to approval, pay out the State benefit. Those who are not members of such associations will draw their benefit through the Labour Exchanges.

Those who have made 500 contributions at least, if over 55 on entry, will, on reaching 60, get a refund of their contributions, less benefit paid, together with interest.

Industries, if approved, may set up special schemes giving superior advantages. If special schemes are not actually set up by November 4th, contributions under the general scheme (less expenditure) will subsequently be paid to the special scheme with a State grant, provided the scheme is in operation before July 4th, 1921. Two or more industries may combine for a special scheme. Such schemes will be administered by a Joint Board of employers and employed, and the form and amount of contributions and benefits may be different from the general scheme.

The Act also provides that an industry may form a supplementary scheme to provide extra benefits, as for short time and the three waiting days.

Explanatory leaflets will shortly be obtainable from the Employment Exchanges.

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By Eric M. Bergstrom, of London.
Associate Member of the Institution of Mechanical Engineers.

(Continued from page 7, Seps, 21.)

Space does not permit, within the limits of this paper, to consider in detail all the important improvements in this respect, but in the following pages will be given a brief description of some prominent modern hydro-electric power plants, embodying various types of turbines and modes of installation which will serve the purpose of illustrating the advances in construction and general layout of hydro-electric power plants.

There is, however, one important detail of construction, namely, the guide-apparatus regulating the quantity of water to be admitted to the turbine, which calls for some preliminary remarks. In the past,

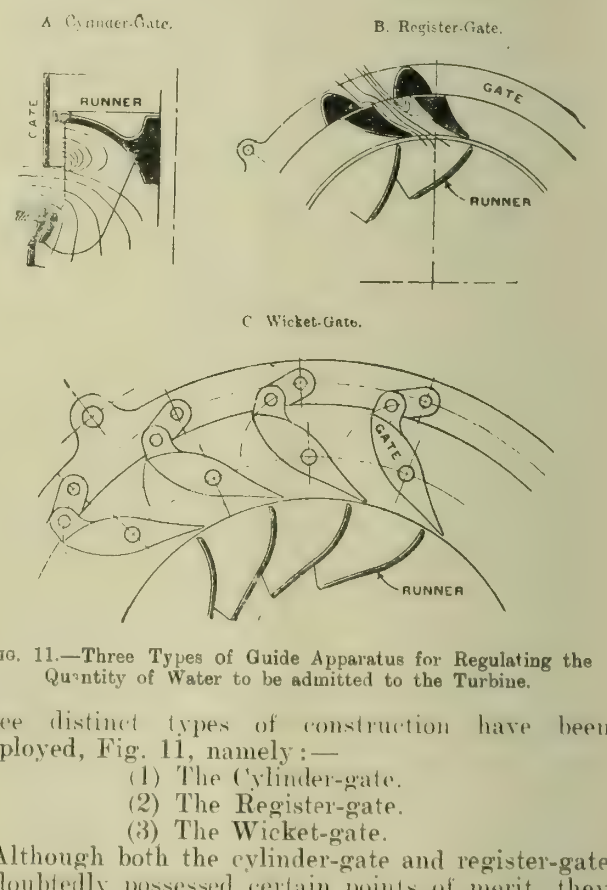


Fig. 11.—Three Types of Guide Apparatus for Regulating the Quantity of Water to be admitted to the Turbine.

three distinct types of construction have been employed, Fig. 11, namely:—

(1) The Cylinder-gate.
(2) The Register-gate.
(3) The Wicket-gate.

Although both the cylinder-gate and register-gate undoubtedly possessed certain points of merit, they have now been superseded by the modern wicket-gate, on account of the improved efficiency obtained by reduced obstruction to the approach of the water to the runner and by eliminating impact losses and formation of eddies, which, particularly at small gate-openings, were a marked disadvantage inherent to the two first-mentioned designs. Modern Francis turbines are now, without exception, equipped with wicket-gate regulation, consisting of a number of fin-shaped vanes, each pivoted on a gate-spindle and obtaining its movement from the regulating ring to which each gate is connected by means of a short link.

From the point of view of application to different heights of fall, the Francis turbine is generally classified as follows: —

(1) Low-pressure turbines up to 75 ft. fall.
(2) Medium-pressure turbines from 75 ft. to 150 ft. fall.
(3) High-pressure turbines from 150 ft. to 550 ft. fall.

The low-pressure turbine is installed in open flume, the medium in circular casing, and the high-pressure in spiral casing, although a distinct line cannot be drawn, as various local conditions have to be taken into consideration in each case.

Low-pressure Francis Turbines.

This type of turbine is generally placed in open flume, to which the water is conducted through an intake channel, the plant being arranged with vertical or horizontal shaft. The latter arrangement has, where local conditions permitted, been adopted in most low-pressure hydro-electric plants in Europe, being arranged with two or more turbines on a common shaft to secure a high speed.

In America, on the other hand, the vertical arrangement has been exclusively adopted in connection with modern low-pressure installations, primarily due to the topographical conditions of the rivers from which the power is utilised, inasmuch as the fall of the river is very often distributed along large distances, and dams have to be built to concentrate the fall, which construction lends itself particularly well to the arrangement of vertical shaft units.

It is in this connection that the most notable developments in hydro-electric power plants have taken place in recent years, and which have been stimulated by the development of the "high capacity" runner, as already referred to. This latter construction has permitted the adoption of the single vertical turbine, which possesses many economic advantages over the arrangement of the multiple runner, either on vertical or horizontal shaft, and has facilitated the promotion of the large-power low-head hydro-electric undertakings which during the last six years have shown such a remarkable development in the United States of America.

(a) Vertical Low-pressure Francis Turbines.

A typical example of this arrangement is the plant of the Mississippi River Power Co., situated at Keokuk, Iowa, and partly completed in 1913, which, apart from its hydraulic features, is of unusual interest as being, when completed, the largest power station in the world, with an output of over 300,000 H.P. under one roof. This power plant is situated on the Mississippi River at the foot of the Des Moines Rapids, the fall of the river being 23 feet in the 12 miles above the Rapids, and a total fall of 32 feet has been obtained by the construction of a dam across the river between Keokuk and Hamilton. The power-house forms part of the dam structure, and is built with its entire length parallel with the river, the area between the power-house and the main bank forming the fore-bay. The power-house is constructed entirely in concrete, and its imposing size can be judged from the fact that the total length is 1,718 ft. by 132 ft. 10 in. wide and 177 ft. 6 in. high from the lowest point in the tail race to the highest point of the roof. Accommodation has been provided for 30 vertical single-runner Francis turbines directly connected to vertical generators of which 15 units are now installed and in operation. The turbines are designed for a normal output of 10,000 H.P. under a net head of 32 ft. and a speed of 57·5 revolutions per minute, although each unit is capable of overload up to 14,000 H.P. under a head of 39 feet.

From a hydraulic point of view, this installation is of particular interest, as it embodies all the modern practice which has been derived from years of careful study and investigation. This particularly refers to the construction of the intake-chamber and suction-tubes, which have been designed to reduce to a minimum the losses due to impact and formation of eddies. For this purpose the turbine is set in volute casing cast in the concrete, which imparts to the water the same entrance velocity at all points round the turbine and removes the possibility of formation of eddies in the intake-chamber, thus ensuring the highest possible efficiency of the turbine. All the sections of the intake and casing have been designed to avoid any sudden changes in velocity and to ensure a gradual and uniform transition in the velocity of the water, which is of most vital importance to enable a high overall efficiency of the plant to be realised.

What has just been said with regard to the importance of observing hydraulic principles in the construction of the intake and setting of the turbine, applies perhaps in a greater degree to the design of the suction or draught tubes. As in the case of the Mississippi plant, recent practice is, as far as conditions permit, to mould the suction-tube direct in concrete and discharge the water at the bottom end parallel to the flow of the tail-race in preference to using steel tubes, as was formerly the practice.

The suction or draught tube was considered one of the great features of the Francis turbine, permitting the erection of the plant at a convenient height above tail-water level without loss of head. In addition, however, it also performs, if properly designed, the very important function of partly recovering the energy corresponding to the velocity of the water when leaving the runner; hence, it becomes necessary to pay particular attention to this part of the construction.

This hydraulic function of the suction tube may be of less importance in connection with slow-speed runners operating under a high head, as the discharge velocity from the runner does not exceed a figure corresponding to approximately 5 per cent of the total head, and in most cases less, but in connection with high-capacity runners, the suction tube becomes one of the most vital parts of the turbine, and, in fact, without this the high-capacity runners would be impracticable owing to the loss of efficiency entailed in not converting the velocity energy of the water when discharging from the runner into useful work. This will be appreciated when it is remembered that the discharge velocity of the water in high-capacity runners may often represent as much as 15 per cent to 20 per cent, and even more, of the total head, which energy without properly designed suction-tubes could not be recovered to the fullest possible extent.

The overall efficiency of modern turbine plants employing high-capacity runners is therefore in a great measure dependent on properly designed suction tubes, ensuring that the velocity of the water

immediately after its discharge from the runner is gradually and uniformly reduced to the minimum velocity when discharging into the tail race, and thereby increasing the total utilised head. This fact has, in many cases, not been sufficiently appreciated, with the result that the plant has been working with a permanent loss of efficiency, which could have been avoided if due consideration had been given to this important section of the plant. In this respect the vertically arranged unit has an advantage over the horizontal construction, as in the absence of suction casing or bends a higher overall efficiency is obtained.

In Fig. 12 is seen the mechanical arrangement of the turbine at the Mississippi River Plant. The turbine is placed just below the floor level of the power house at the bottom of a short shaft lined with a steel casing. One upper and lower heavy foundation ring is embedded in the concrete conforming to the inner circumference of the volute casing, and rigidly connected by means of strong stay bolts.

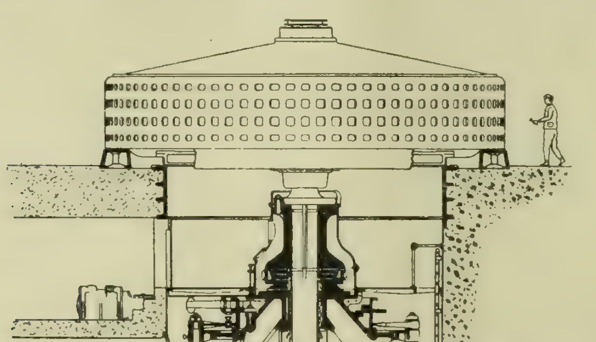


FIG. 12.—Turbine at the Mississippi River Plant.

which transmit the total weight of the unit to the foundations of the power house. The runner is of most formidable dimensions, being the largest size runner in the world, with a diameter at the discharge of 17 ft. 4 in., and a total weight of 80 tons.

The spindle of each guide-vane passes through a separate stuffing-box and connects with the common regulating ring by means of a lever, which in its turn obtains its movement from the servo-motor of the automatic oil-pressure governor. This system of regulation is now the practice adopted in all large vertical units. As all the regulating connections are above water, it permits inspection when running, access being gained from the power-house floor through a separate inspection shaft.

This plant also illustrates a new departure in the design of guide-bearings just above the runner. Previous practice was to use a lignum vitæ underwater bearing, consisting of three blocks fitted in a cast-iron shoe with adjusting screws for taking up the wear. This design of guide-bearing is unsatisfactory in connection with large units on account of the small bearing-surface and the frequent adjustments necessary. The guide-bearing now adopted consists of a large number of lignum vitæ strips dovetailed into the bearing-boxes, evenly spaced round the whole circumference of the shaft, the small space between each strip allowing the water to circulate round the bearing. It is also an advantage to use this type as an outside guide-bearing when the turbine is not submerged, in preference to babbit-lined bearings, as the bearing can be placed close up to the runner and pressure water used as lubricant; thus the necessity of providing circulating pumps for oil is dispensed with.

The most important mechanical detail in connection with vertically arranged turbines is the thrust-bearing, on the construction of which perhaps the whole plant depends for satisfactory and continuous operation. It must be admitted that a strong prejudice existed in the minds of many engineers against thrust-bearings, which in many instances militated against the adoption of the vertical arrangement for large units, and the question of the most reliable type of bearing for such plants, when the load to be supported may exceed 250 tons as in the case of the Mississippi plant, naturally compelled most careful thought and consideration. In America, at any rate, the present practice is to use one thrust-bearing only, which, in addition to the weight of and water-pressure on the runner, has to carry the weight of the rotor of the generator, whereas European engineers up to the present have preferred to have a separate bearing for the generator.

The types of bearing which have been used for this purpose are: (1) Oil-pressure thrust-bearing; (2) ball or roller-bearing; (3) "Kingsbury" bearing.

The oil-pressure thrust-bearing consists of one stationary and one rotating disc between which oil is pumped under pressure. For small loads, oil under pressure is not necessary, and the two discs revolve in an oil-bath, although for large plants the load is generally too excessive to permit the use of this latter type of bearing.

The introduction of ball and roller-bearings, which are now employed in every possible sphere of engineering, signified a further advance in the construction of thrust bearings. Ball or roller-bearings, or both combined, have been used as thrust-bearings in connection with vertical turbines with unqualified success, and have now more or less substituted the oil-pressure bearing with its intricate system of pumps and pipe connections, and thus removed the danger attached to any breakdown of the oil-pressure supply, to which this type of bearing was liable.

(To be continued.)

MOTOR LORRY WORKS AT BILBAO.—The question is being discussed of establishing motor lorry works in Bilbao, and it is said that the Hispano-Suiza is interested in the enterprise.—Reuter.

SPANISH SHIPBUILDING COMPANY APPLIES FOR GOVERNMENT ASSISTANCE.—The Sociedad Hijos de J. Barrera, of Vigo, has solicited State aid for its shipbuilding and repairing works, which deal with vessels of 2,000 tons and over, and use exclusively Spanish machines.—Reuter.

BOILERS FOR INDUSTRIAL PURPOSES.

By Ernest Pull, A.M.I.Mech.E., M.I.Mar.E., R.N.R.

The horse power of a boiler has been, and in many cases is still, based upon the horse power of the engine it supplies with steam. The nominal horse power of a boiler is, even at the present time, calculated according to the amount of its heating surface, 10 to 12 sq. ft. being allowed per horse power. Both of these methods of classification are of very little use, because the various types of engines in use require different amounts of steam per indicated horse power, according to their design and efficiency.

Another method of indicating the nominal horse power of a boiler was based on the evaporation of one cubic foot or 62 lb. of water per hour. This method also is of little value.

The amount of steam required by an engine to develop one horse power varies between 11 lb. and 40 lb., or even more; while feed pumps and certain other auxiliaries often require as much as 150 lb. of steam per indicated horse power.

The following figures give the approximate steam consumption of various types of engines per indicated horse power hour:—

High-class triple and quadruple engines under favourable conditions, 11 lb. to 13 lb. of steam.

Triple and quadruple engines under ordinary conditions, 12 lb. to 15 lb. of steam.

Triple and quadruple engines under variable loads, 15 lb. to 20 lb. of steam.

Compound engines under variable loads, 18 lb. to 25 lb. of steam.

Simple condensing engines, 25 lb. to 35 lb. of steam.

Simple non-condensing engines, 30 lb. to 40 lb. of steam.

Simple condensing engines of small size and inferior make, 40 lb. upwards.

To allow for economical working, and to give an ample supply of steam, at least 50 per cent more than the above figures should be allowed.

The power of a boiler should be in terms of horse power, because the energy is actually generated in the boiler, the engine taking its steam power from the boiler, using some and wasting most. It is obviously unfair to hold the boiler responsible for the shortcomings of the engine, as it is the function of the boiler to generate power, and not to develop it.

The following example will show the futility of indicating the horse power of a boiler according to the power developed in the engine:—

Example: Grate area of boiler, 45 sq. ft.; coal consumption, 24 lb. per sq. ft.; water evaporated per pound of fuel, 8·5 lb.; then water evaporated per hour $= 45 \times 24 \times 8{\cdot}5 = 9{,}180$ lb.

If the boiler is supplying a simple type of non-condensing engine, using 30 lb. of steam per horse power hour, the horse power developed would be $9{,}180 \div 30 = 306$; whereas, if a modern type of quadruple condensing engine, using only 12 lb. of steam per hour, is being supplied, then the horse power developed would be $9{,}180 \div 12 = 765$, or exactly $2\frac{1}{2}$ times greater.

The most useful method of indicating the power of a boiler, and one which steam users should insist upon, is the evaporation at a given pressure of an equivalent of a definite number of pounds of water from and at 212 deg. Fah., when burning a certain amount of fuel per square foot of fire-grate under normal conditions of draught. The only question of doubt, then, would be the calorific value of the fuel; but if this was also given, the equivalent evaporation for fuel of different calorific value could be found by calculation.

The evaporation of water by any boiler can be found within practical limits by means of tests, and if the steam consumption of the engine or plant to be supplied is known, then the horse power of the boiler required to supply the plant can easily be calculated.

In order to decide upon a particular design of boiler for any purpose, the following particulars must first be obtained and carefully considered:—

(1) The approximate number of pounds of water to be evaporated per hour.
(2) The class of fuel that will be used.
(3) The possibility of variation in load.
(4) Steam pressure.
(5) Durability and simplicity of design.
(6) Available floor space.
(7) Quality of water to be used for feed.
(8) Efficiency and economy with regard to initial cost.
(9) Future increase in size of plant.
(10) Transport difficulties.

The evaporative efficiency of a boiler is the percentage ratio between the heat developed in the boiler by the combustion of the fuel, and the heat absorbed by the water. This can be expressed as:—

$$\text{Efficiency} = \frac{\text{heat absorbed by water per lb. of fuel}}{\text{heat generated per lb. of fuel.}}$$

The efficiency can also be taken as the ratio of the amount of heat contained in the fuel to the heat transmitted to the water; or the amount of water evaporated from and at 212 deg. Fah., divided by the amount of water which the fuel would evaporate if all its heat were transmitted to the water.

To find the efficiency of a boiler, let:—

W = water evaporated per pound of fuel.
C = calorific value of fuel.
H = total heat of 1 lb. of steam from 212 deg. Fah. to temperature of steam.

Then percentage efficiency of boiler =

$$\frac{W \times H}{C} \times 100$$

—*Machinery Market.*

Detroit-Windsor Suspension Bridge.—The proposal to connect Detroit and Windsor with a bridge across Detroit River has moved nearer fruition by a meeting of representatives of 25 prominent capitalists at Detroit, when 10,000,000 dols. was guaranteed for such construction. It is estimated the bridge would cost about 28,000,000 dols., and would be of the suspension type. Negotiations are already under way to obtain the remainder of the sum needed. Tentative plans call for a bridge about 2,000 ft. long, carrying two 7 ft. sidewalks, two street car tracks, and four railway tracks. The bridge would be 110 ft. high at the centre, and 100 ft. high at each end. This would be in line with an agreement with the Great Lakes Carrier Association. An enquiry into the needs of vessels that would use the proposed Great Lakes–St. Lawrence waterway has shown that no wireless masts more than 100 ft. high will be required on ships.—Reuter.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 21, Aug. 21.*)

Origin of Wanner's Pyrometer.

The application of polarised light to pyrometery furnishes a very good illustration of the utility of optics in industrial work. For photometric purposes polarised light was used by Helmholtz, Maxwell, Wild, and others. It has been chiefly for the branch of photometry, called spectro-photometry, that polarised has been applied. A spectro-photometer is designed for the purpose of comparing the intensities of the colours emitted by different sources of light. One of the best known of these instruments is that of A. König, who in 1894, in "Wiedemann's Annalen," described a new optical train, which has been since employed for various industrial purposes. In the same year, E. Kötten used the König instrument in an investigation relating to gas and other lights. In 1900, H. Wanner found the apparatus of utility in applying the law of Wien (see previous article) for photographic purposes, which led him to the introduction of the instrument as a commercial pyrometer now extensively used by metallurgists in all countries. It is regarded as the most accurate means hitherto designed for very high temperature determinations.

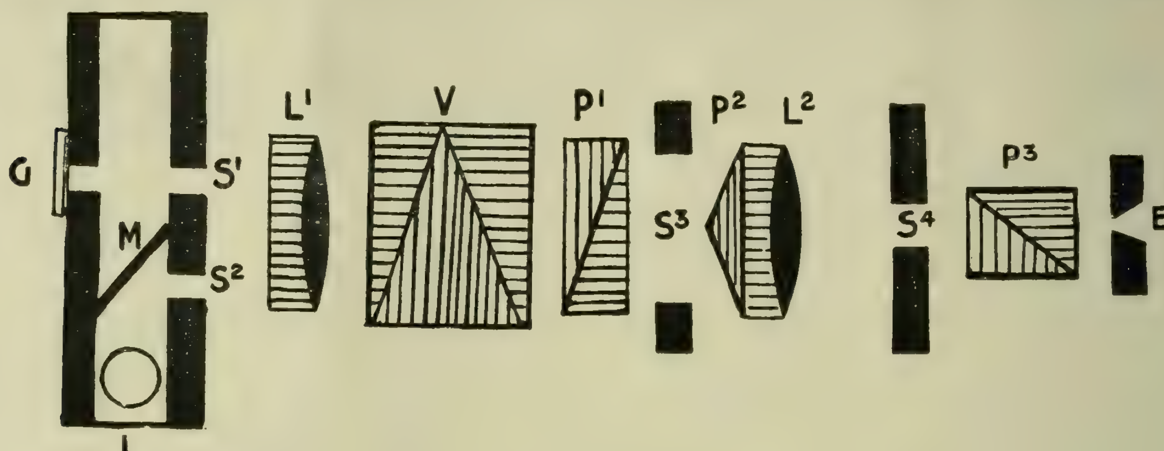


Fig. 10.

Optics of Wanner's Pyrometer.

The complicated optical arrangements are shown diagrammatically in Fig. 10. The light from the distant source, whose temperature has to be measured, passes through the window G and thence through the slit S_1, whilst that from the comparison electric lamp L, after passing through a diffusing glass, is reflected from the mirror M into the slit S_2. Both beams are made parallel by the achromatic lens L_1, and next whilst passing through the direct vision prism V, are drawn out into spectra. Only the corresponding red waves are used in the measurements, the remaining colours being cut out of the field of view by screens. The next course is through the Rochon prism P_1, where the two red rays are divided into two beams polarised at right angles. The four beams pass through the diaphragm S_3, and reach the biprism P_2, which is cemented to the achromatic lens L_2, whereby the number of images are increased to eight, but only two of each pass through the slit S_4, the others being arrested by screens. These two red beams traverse the analyser P_3, and thence to the eye of the observer at E.

Use of Wanner's Pyrometer.

The type adopted for temperatures from 840 deg. Cen. to 7,000 deg. Cen. is shown in Fig. 11, in the process of standardisation. On the wooden base M the pyrometer P is supported on the standard B, being held in place by two brass springs. At N is the amyl acetate lamp, having a sighting frame V, one arm of which carries a frosted glass screen. The correct position of the pyrometer head is when it is in contact with a stop R, and the pyrometer pushed close as possible to the sighting frame. After lighting the lamp it is allowed to burn for about 10 minutes to get into a steady condition, and the height of the flame adjusted until its yellow tip is precisely at the height of the sighting gauge. By inserting the plug into S the lamp in the pyrometer is connected to a three-cell storage battery, which

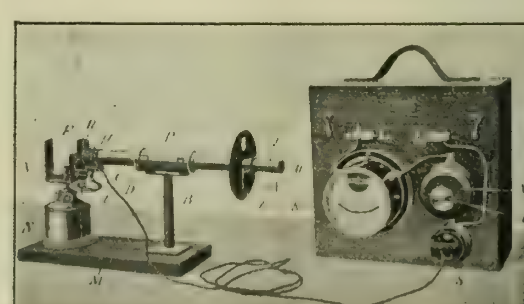


Fig. 11.

must have the correct voltage of 6·4. The current is adjusted by turning the screw G of the rheostat W, and the current is read off on the ammeter K.

On looking through the ocular O a red circle is seen, the upper half being lighted by the electric lamp and the lower half by the amyl acetate lamp. In making this observation the index arm Z should have previously been set at a certain normal position. If the two halves of the field are not equal

the rheostat is adjusted until they are so, and a note must be made of the reading of the ammeter.

Comparison of Intensities of Illumination.

How the intensities of the beams reaching the analyser are compared must now be discussed. As we are only dealing with monochromatic light, the waves from the two sources will differ only in amplitude. The question arises how will the intensity of the light vary with the amplitude of the wave motion? A study of all kinds of harmonic motions results in the law that the intensity varies as the square of the amplitude, thus the loudness of a sound note varies with the square of the amplitude of its vibration. Next, we have to remember that the lights from the two sources are vibrating in planes at right angles to each other. Thus, in Fig. 12, the direction and extent of vibration of the two lights may be represented by OP and OQ, the former being from the hot source. Let OR be the plane of transmission of the analyser, when the two halves of the field of view appear of the same bright-

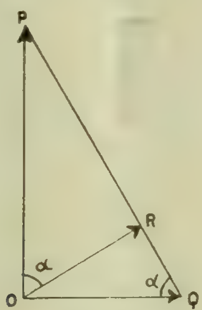


Fig 12.

ness. This implies that OR is equal to the resolved portion of OP and also to the resolved portion of OQ, and therefore :—

$$OR = OP \cos \alpha = OQ \sin \alpha,$$

hence $$OP / OQ = \tan \alpha.$$

Representing the brightness of the view of the hot body by I, and that of the lamp by I_1, we have from the above :—

$$I / I_1 = OP^2 / OQ^2 = \tan^2 \alpha,$$

which is the photometric law of the Wanner pyrometer assumed previously.

The Normal Angle of the Pyrometer.

Whilst balancing the electric lamp against the amyl acetate standard the analyser is usually set at an angle of 45 deg., with the plane of polarisation of each beam. It is at this angle that the instrument is most sensitive for a change of angular position. At this angle small changes of intensity will require relatively large movements of the analyser, whereas for large and small angles less accurate readings can be made. This is the case of all instruments obeying a tangent law, such as the tangent galvanometer. In the optical pyrometer in which the intensities to be compared vary as the square of the tangent of the angle, it is very important that all its readings be accurate, and determinations should not differ too much from 45 deg. Should the intensity of the light from the hot source be much higher than that of from the electric lamp, it is usual to employ a glass absorbing screen in front of the slit.

Method of Use of the Pyrometer.

The standardisation having been effected and the ammeter reading noted, the instrument is then directed through the sight hole of a furnace or to any hot body, and the analyser is rotated until both halves of the field of view are of equal intensity. The angle is now read off, and the temperature obtained from a calibration table, or directly from a scale on

Fig. 13.

the instrument. Care must be taken at each reading that the ammeter reading is as fixed during standardisation, any change being corrected by the rhetosat. When in use the pyrometer may be held in the left hand, as shown in Fig. 13, and the analyser rotated by the right hand; or the instrument may be supported on a tripod stand as shown. It is advisable in positions where the temperature is high to protect the pyrometer by using an asbestos shield. The following table will give an idea of the accuracy and range of temperatures in centigrade degress attainable with different types of pyrometers made in 1910 by Hase, of Hanover.

Table of Pyrometer Scales.

Reading.	1	2	3	4	5	6	7
10	627	739	925	945	1,100	1,620	...
20	703	849	1,025	1,050	1,230	1,890	3,125
40	768	945	1,165	1,200	1,420	2,300	4,175
60	801	992	1,315	1,355	1,640	2,820	5,775
64	805	999	1,355	1,399	1,696	2,980	6,275
80	...	...	1,640	1 695	2,120	4,350	...
86	...	...	2,000	2,031	...	...	...

(To be continued.)

Mr. Lascelles Parrington, A.M.I.E.E., Collins House, 360-366, Collins Street, Melbourne, has been appointed sole agent in Australia for Wild-Barfield electric furnaces.

New Dairy Machinery Company in Stockholm. A new company has been formed at Stockholm for the purpose of exploiting Engineer E. G. N. Galenius' inventions and patents relating to dairy machinery. The name of the company will be Svenska Separatorverken Amerika-Sweden Aktiebolag, and the minimum capital is fixed at Kr.8,000,000. M. Ernst Mentor is to be managing director and the vice-managing director will be M. Gunnar Selenius.—Reuter.

Aeroplane Manufacturer's Big Claim. The Paris "Matin" states that Mr. Esnault-Peltorie, the areoplane manufacturer, is claiming a round sum of Fr.66,000,000 from all aeroplane manufacurers, on the ground that he, the inventor of the control lever (joystick) in aeroplanes, has not been remunerated in any way for his invention, which was universally employed during the war. It is stated that aeroplane manufacturers have threatened to close their workshops in consequence of the claim.—Reuter.

CENTRIFUGAL CLUTCHES.

EVERY engineer has experienced the annoyance and waste of time that is frequently caused by fusing when starting motors. The trouble is greater if a large starting torque is required. The centrifugal clutches made by Messrs. T. Broadbent & Sons Ltd., Huddersfield, have been designed to obviate this difficulty, and with their use a motor can be started with a minimum starting current and without any special switch gear. The clutches are entirely automatic, the load being taken up gradually as the motor accelerates. They can be designed to allow the motor to run up to 75 per cent of full speed before motor extension shaft driving a chain sprocket wheel.

There are many advantages claimed for this type of clutch. It is very simple, and the rate of starting is entirely automatic. The operator cannot make a mistake, because the load is taken up quite independently of his judgment. There is absolutely no jerk, and the rate of acceleration depends upon the design of the clutch. Another very good point is that it acts as a flexible coupling, and thus prevents sudden shocks being transmitted to the motor. The only wearing parts are the slipper faces, and they can be renewed very quickly and cheaply. They ought to effect a considerable saving in current consumption, and thus soon repay the first cost.

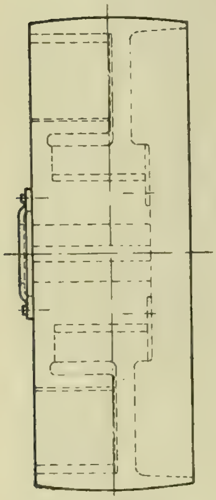


FIG. 1.

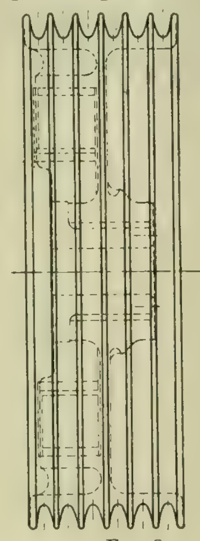


FIG. 2.

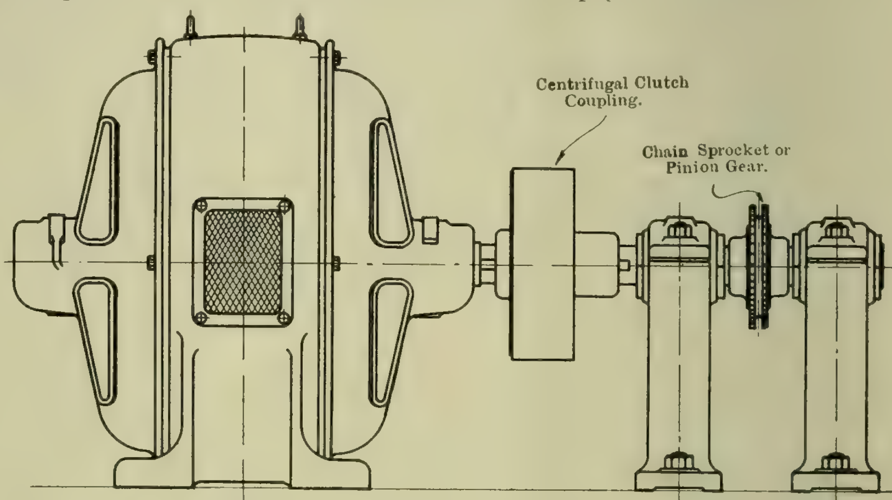


FIG. 3.

taking up the load, and are especially suitable for use with alternating current motors of the squirrel cage type, as this type of motor has a poor starting torque.

Different Forms.

A clutch, which may take the form of either a coupling or a pulley can be used for main line shafting, looms, machine tools, hydraulic pumps, etc., should be a great help when used in conjunction with gas and oil engines which are required to start up against load.

The diameter of the clutch is determined by the horse power and the speed of the motor with which it is combined, but, of course, the diameter of the pulley is not fixed. Fig. 1 shows a clutch combined with a belt pulley when the pulley is of such a size as to permit of the clutch being arranged in the interior. When the pulley is too small to allow of this being done, the clutch is fitted along side it, and this is a somewhat clumsy arrangement, but it does not interfere with the belt. When two or three pulleys, probably of different diameters, are joined together the clutch is exterior as for a small pulley.

Adaptability.

The adaptability of these clutches is clearly demonstrated in Fig. 2, which shows one fitted inside a rope pulley for main driving to line shafting. They can also be used in combination with tooth wheels, the pinion being keyed to the clutch boss. Fig. 3 illustrates a clutch used as a coupling for a

Fig. 4 is an end view of a clutch pulley transmitting 70 H.P. at 480 revolutions per minute.

They are proving very useful in textile mills; ring spinning frames can be driven direct by motor

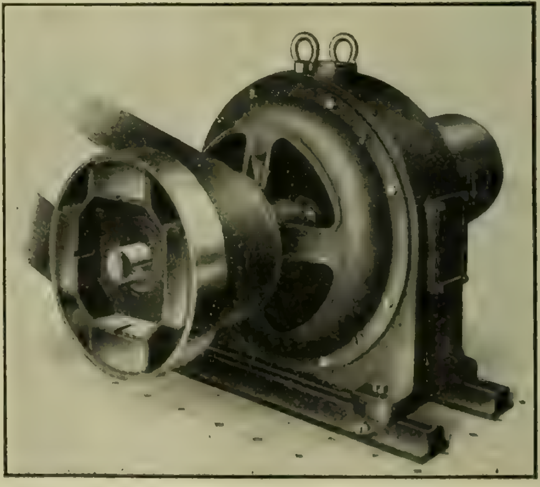


FIG. 4.

fitted with clutch couplings. The motor gets up to practically full speed, and the clutch then gradually accelerates the machine to its normal speed without breaking down the yarn.

THE MACHINE TOOL EXHIBITION.

The exhibition is bewildering in its comprehensiveness. It is probably the finest display of large and small machine tools ever brought together under one roof. Not only are the latest types of heavy metal working machines on view, but there are several stands of woodworking machines, foundry machines, box-making machines, sewing machines, and the latest precision measuring devices. The power user who is not an engineer can study the most recent devices for the cheap transmission of power. It is a revelation of what the war taught us. No industry has benefited by the war more than the machine tool trade. In 1914 the nation found the rapid production of all sorts of munitions of war by comparatively unskilled labour absolutely necessary. Neither the machines were ready nor was the organisation perfected for making them, but the manufacturers rose to the occasion. There was a period of intensified development, and by resourceful inventiveness the production rose to the requirements.

We shall not depend as much on foreign machine tools in future as we did in the past. Many engineering firms entered the machine tool trade during the war, and in order to make quantity production possible each firm specialises in a special class of tool. This eliminates "cutting," and is certainly in the national interest, as it enables the trade to compete with American and German firms. One cannot help feeling regret the German products have been excluded from Olympia. It would have been instructive to have compared recent German designs, also the outcome of the war's "necessities," with our own. The value of comparison would have been great.

It is impossible to deal adequately here with any but a few of the exhibits. The catalogue is over 400 pages. It is difficult even to summarise the list of recent developments. Centralised control is obviously a help to quantity production, and has received much notice. There are modifications of lathe beds, many new improvements in tail and headstocks, such as clamping, and an extension of the use of the push button control method to facilitate starting and stopping. The modification of woodworking and foundry machines are few, but the growing importance of grinding as a finishing process is obvious from the number of interesting exhibits of this nature.

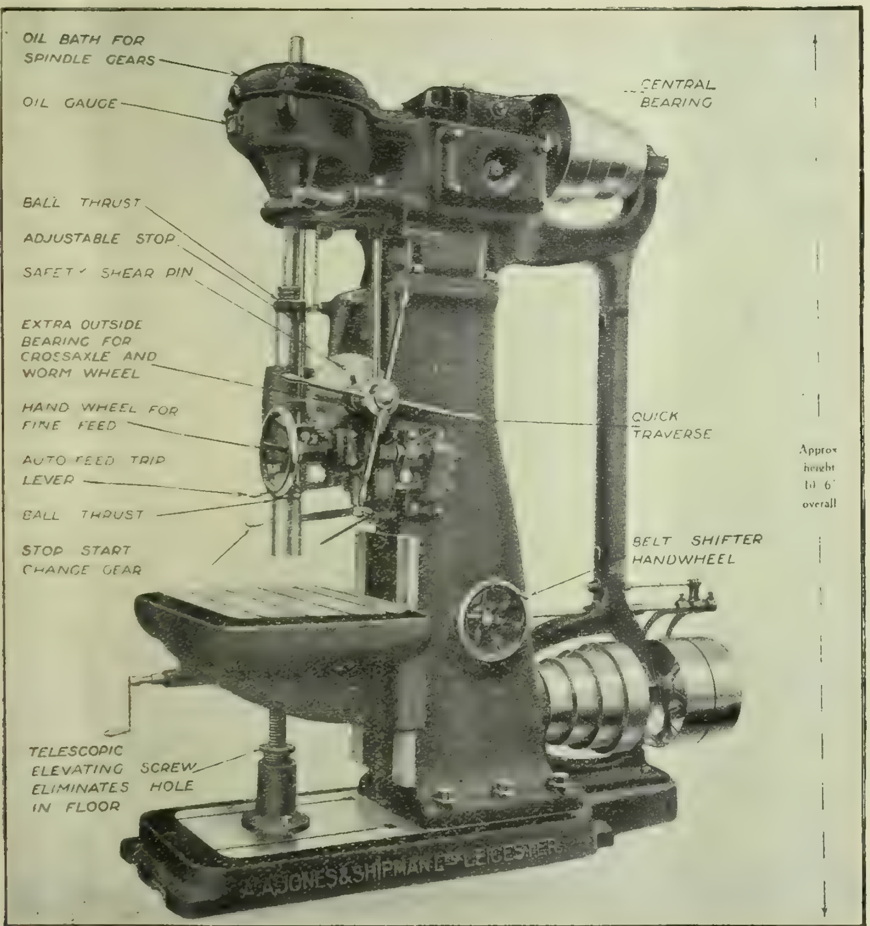


Fig. 1.

Messrs. Jones & Shipman.

This firm exhibits an interesting 30 in. upright drilling and tapping machine, which is shown in Figs. 1 and 2. It will bore a 2 in. diameter hole

through solid steel shell in two minutes. The machine was designed for continuous heavy duty on repetition work in connection with the manufacture of munitions of war, and is satisfactory for ordinary commercial repetition work. There are eight spindle speeds, four through single and four through double gearing provided, together with nine changes of positive automatic feed. Tapping reverse is incorporated when required. Drilling can be done at the highest speed and feed the twist drill used is prevents chips entering the tank. The tank is incorporated in the base, and is provided with a large cover for cleaning purposes. The spindle drive is through bevelled gearing with 3–1 reduction, the bevel pinion is hard steel, ball thrust bearings taking the end thrust of the bevels. The automatic feed has nine rates of penetration, the drive being obtained through a high-grade roller chain from the drill spindle through an all-steel gear box. The wheel gearing has a hardened steel worm revolving

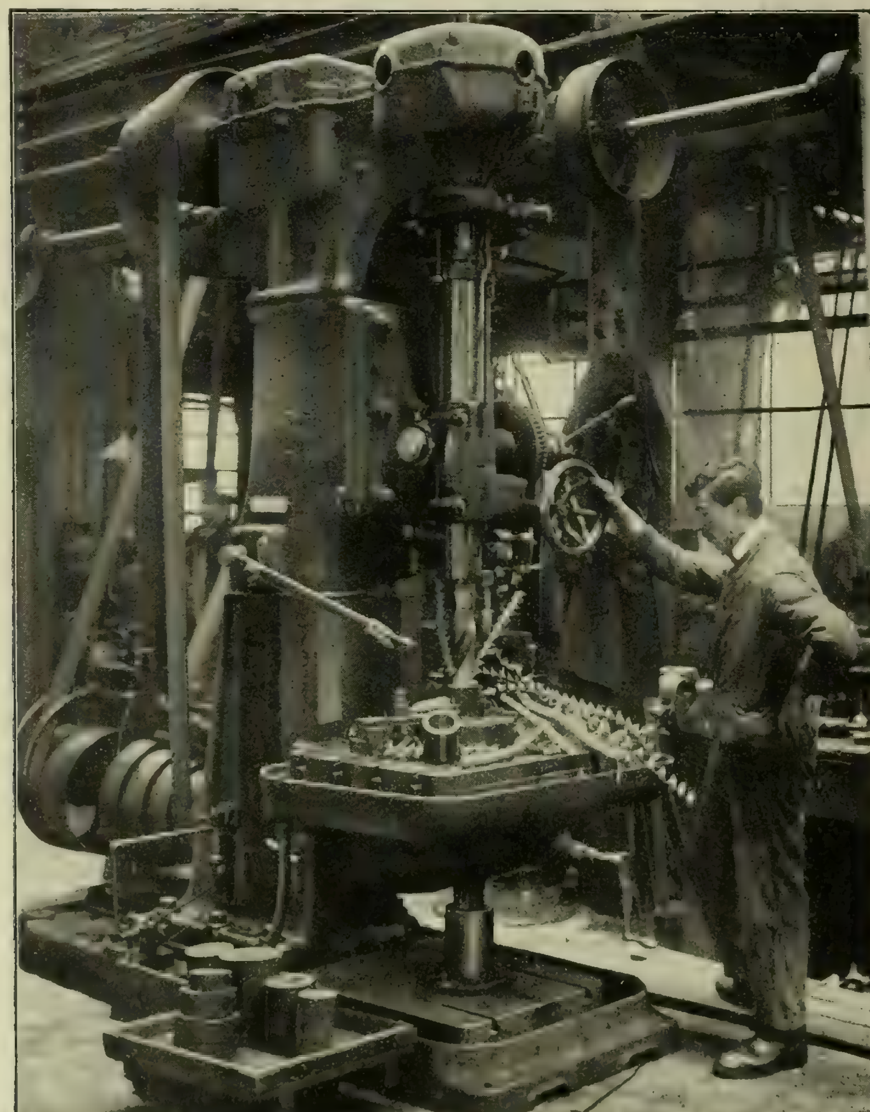


FIG. 2.

capable of standing up to, the rate of drilling being limited only by its endurance. Tables, plain or compound, may be fitted to the vertical slideways on the front of the column, or a table at a fixed height may be supplied, fitted to the base.

The whole machine is very strongly built. The base is heavily webbed to eliminate vibration, and accurately planed to accommodate large work. Tee slots and a wide suds channel are provided. The channel is inclined to a large sump in the lowest plane, which is provided with a removable filter which

in an oil bath, and the phosphor bronze worm wheel is fitted with a safety shear pin, set to shear at a load which would other damage the machine—a protection against carelessness, while the automatic trip mechanism allows drilling and tapping to be performed to exact depths. There is a positive automatic adjustable stop to read the depth desired to be drilled, the vertical stop-bar being graduated in fractions of inches, and a safety knock-out, which is always set, eliminates the possibility of the drill spindle over-running its stroke.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × $7\frac{1}{2}$ in. × 93 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 1 6	0 16 2 12	1 4 3 18	1 13 0 24	2 1 2 2	2 9 3 8	2 18 0 14	3 6 1 20	3 14 2 26	0
1	0 3 9	9 0 15	0 17 1 21	1 5 2 27	1 14 0 5	2 2 1 11	2 10 2 17	2 18 3 23	3 7 1 1	3 15 2 7	1
2	1 2 18	9 3 24	0 18 1 2	1 6 2 8	1 14 3 14	2 3 0 20	2 11 1 26	2 19 3 4	3 8 0 10	3 16 1 16	2
3	2 1 27	10 3 5	0 19 0 11	1 7 1 17	1 15 2 23	2 4 0 1	2 12 1 7	3 0 2 13	3 8 3 19	3 17 0 25	3
4	3 1 8	11 2 14	0 19 3 20	1 7 0 26	1 16 2 4	2 4 3 10	2 13 0 16	3 1 1 22	3 9 3 0	3 18 0 6	4
5	4 0 17	12 1 23	1 0 3 1	1 8 0 7	1 17 1 13	2 5 2 19	2 13 3 25	3 2 1 3	3 10 2 9	3 18 3 15	5
6	4 3 26	13 1 4	1 1 2 10	1 8 3 16	1 18 0 22	2 6 2 0	2 14 3 6	3 3 0 12	3 11 1 18	3 19 2 24	6
7	5 3 7	14 0 13	1 2 1 19	1 9 2 25	1 19 0 3	2 7 1 9	2 15 2 15	3 3 3 21	3 12 0 27	4 0 2 5	7
8	6 2 16	14 3 22	1 3 1 0	1 10 2 6	1 19 3 12	2 8 0 18	2 16 1 24	3 4 3 2	3 13 0 8	4 1 1 14	8
9	7 1 25	15 3 3	1 4 0 9	1 11 1 15	2 0 2 21	2 8 3 27	2 17 1 5	3 5 2 11	3 13 3 17	4 2 0 23	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·75	15·5	23·25	1 3	1 10·75	1 18·5	1 26·25	2 6	2 13·75	2 21·5	3 1·25	3 9	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × $7\frac{1}{2}$ in. × 93 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 3 0 4	8 6 0 8	12 9 0 12	16 12 0 16	20 15 0 20	24 18 0 24	29 1 1 0	33 4 1 4	37 7 1 8	0
10	0 8 1 6	4 11 1 10	8 14 1 14	12 17 1 18	17 0 1 22	21 3 1 26	25 6 2 2	29 9 2 6	33 12 2 10	37 15 2 14	10
20	0 16 2 12	4 19 2 16	9 2 2 20	13 5 2 24	17 8 3 0	21 11 3 4	25 14 3 8	29 17 3 12	34 0 3 16	38 3 3 20	20
30	1 4 3 18	5 7 3 22	9 10 3 26	13 14 0 2	17 17 0 6	22 0 0 10	26 3 0 14	30 6 0 18	34 9 0 22	38 12 0 26	30
40	1 13 0 24	5 16 1 0	9 19 1 4	14 2 1 8	18 5 1 12	22 8 1 16	26 11 1 20	30 14 1 24	34 17 2 0	39 0 2 4	40
50	2 1 2 2	6 4 2 6	10 7 2 10	14 10 2 14	18 13 2 18	22 16 2 22	26 19 2 26	31 2 3 2	35 5 3 6	39 8 3 10	50
60	2 9 3 8	6 12 3 12	10 15 3 16	14 18 3 20	19 1 3 24	23 5 0 0	27 8 0 4	31 11 0 8	35 14 0 12	39 17 0 16	60
70	2 18 0 14	7 1 0 18	11 4 0 22	15 7 0 26	19 10 1 2	23 13 1 6	27 16 1 10	31 19 1 14	36 2 1 18	40 5 1 22	70
80	3 6 1 20	7 9 1 24	11 12 2 0	15 15 2 4	19 18 2 8	24 1 2 12	28 4 2 16	32 7 2 20	36 10 2 24	40 13 3 0	80
90	3 14 2 26	7 17 3 2	12 0 2 6	16 3 3 10	20 6 3 14	24 9 3 18	28 12 3 22	32 15 3 26	36 19 0 2	41 2 0 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Weight.
	41 10 1 12	83 0 2 24	124 11 0 8	166 1 1 20	207 11 3 4	249 2 0 16	290 12 2 0	332 2 3 12	373 13 0 24	415 3 2 8	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 94 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 1 16	0 16 3 4	1 5 0 20	1 13 2 8	2 1 3 24	2 10 1 12	2 18 3 0	3 7 0 16	3 15 2 4	0
1	0 3 10	9 0 26	0 17 2 14	1 6 0 2	1 14 1 18	2 2 3 6	2 11 0 22	2 19 2 10	3 7 3 26	3 16 1 14	1
2	1 2 20	10 0 8	0 18 1 24	1 6 3 12	1 15 1 0	2 3 2 16	2 12 0 4	3 0 1 20	3 8 3 8	3 17 0 24	2
3	2 2 2	10 3 18	0 19 1 6	1 7 2 22	1 16 0 10	2 4 1 26	2 12 3 14	3 1 1 2	3 9 2 18	3 18 0 6	3
4	3 1 12	11 3 0	1 0 0 16	1 8 2 4	1 16 3 20	2 5 1 8	2 13 2 24	3 2 0 12	3 10 2 0	3 18 3 16	4
5	4 0 22	12 2 10	1 0 3 26	1 9 1 14	1 17 3 2	2 6 0 18	2 14 2 6	3 2 3 22	3 11 1 10	3 19 2 26	5
6	5 0 4	13 1 20	1 1 3 8	1 10 0 24	1 18 2 12	2 7 0 0	2 15 1 16	3 3 3 4	3 12 0 20	4 0 2 8	6
7	5 3 14	14 1 2	1 2 2 18	1 11 0 6	1 19 1 22	2 7 3 10	2 16 0 26	3 4 2 14	3 13 0 2	4 1 1 18	7
8	6 2 24	15 0 12	1 3 2 0	1 11 3 16	2 0 1 4	2 8 2 20	2 17 0 8	3 5 1 24	3 13 3 12	4 2 1 0	8
9	7 2 6	15 3 22	1 4 1 10	1 12 2 26	2 1 0 14	2 9 2 2	2 17 3 18	3 6 1 6	3 14 2 22	4 3 0 10	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	7·84	15·68	23·52	1 3·36	1 11·20	1 19·04	1 26·88	2 6·72	2 14·56	2 22·40	3 2·24	3 10·08	

Weights of Lengths of Rolled Steel Sections.

Beam 20 in. × 7½ in. × 94 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 3 3 20	8 7 3 12	12 11 3 4	16 15 2 24	20 19 2 16	25 3 2 8	29 7 2 0	33 11 1 20	37 15 1 12	0
10	0 8 1 16	4 12 1 8	8 16 1 0	13 0 0 20	17 4 0 12	21 8 0 4	25 11 3 24	29 15 3 16	33 19 3 8	38 3 3 0	10
20	0 16 3 4	5 0 2 24	9 4 2 16	13 8 2 8	17 12 2 0	21 16 1 20	26 0 1 12	30 4 1 4	34 8 0 24	38 12 0 16	20
30	1 5 0 20	5 9 0 12	9 13 0 4	13 16 3 24	18 0 3 16	22 4 3 8	26 8 3 0	30 12 2 20	34 16 2 12	39 0 2 4	30
40	1 13 2 8	5 17 2 0	10 1 1 20	14 5 1 12	18 9 1 4	22 13 0 24	26 17 0 16	31 1 0 8	35 5 0 0	39 8 3 20	40
50	2 1 3 24	6 5 3 16	10 9 3 8	14 13 3 0	18 17 2 20	23 1 2 12	27 5 2 4	31 9 1 24	35 13 1 16	39 17 1 8	50
60	2 10 1 12	6 14 1 4	10 18 0 24	15 2 0 16	19 6 0 8	23 10 0 0	27 13 3 20	31 17 3 12	36 1 3 4	40 5 2 24	60
70	2 18 3 0	7 2 2 20	11 6 2 12	15 10 2 4	19 14 1 24	23 18 1 16	28 2 1 8	32 6 1 0	36 10 0 20	40 14 0 12	70
80	3 7 0 16	7 11 0 8	11 15 0 0	15 18 3 20	20 2 3 12	24 6 3 4	28 10 2 24	32 14 2 16	36 18 2 8	41 2 2 0	80
90	3 15 2 4	7 19 1 24	12 3 1 16	16 7 1 8	20 11 1 0	24 15 0 20	28 19 0 12	33 3 0 4	37 6 3 24	41 10 3 16	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	41 19 1 4	83 18 2 8	125 17 3 12	167 17 0 16	209 16 1 20	251 15 2 24	293 15 0 0	335 14 1 4	377 13 2 8	419 12 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

This firm has many other interesting drilling machine exhibits, besides lathes and milling machines, innumerable small tools, and a comprehensive lot of grinding machines for internal and external grinding.

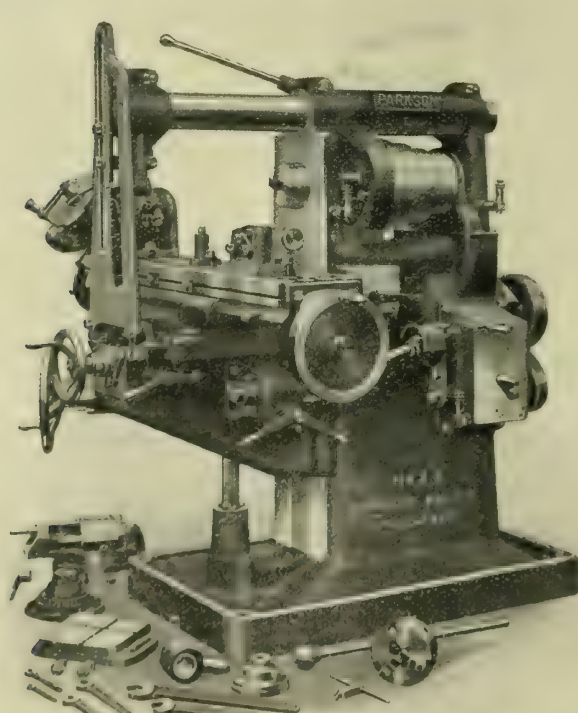


Fig. 4.

Messrs. A. Herbert Ltd.

A lathe which is attracting considerable attention, and is on one of the stands of this firm, is the No. 5 auto-lathe (Fig. 3), and represents the latest in this type of machine. The head is completely enclosed so that the gears run in an oil bath. It is

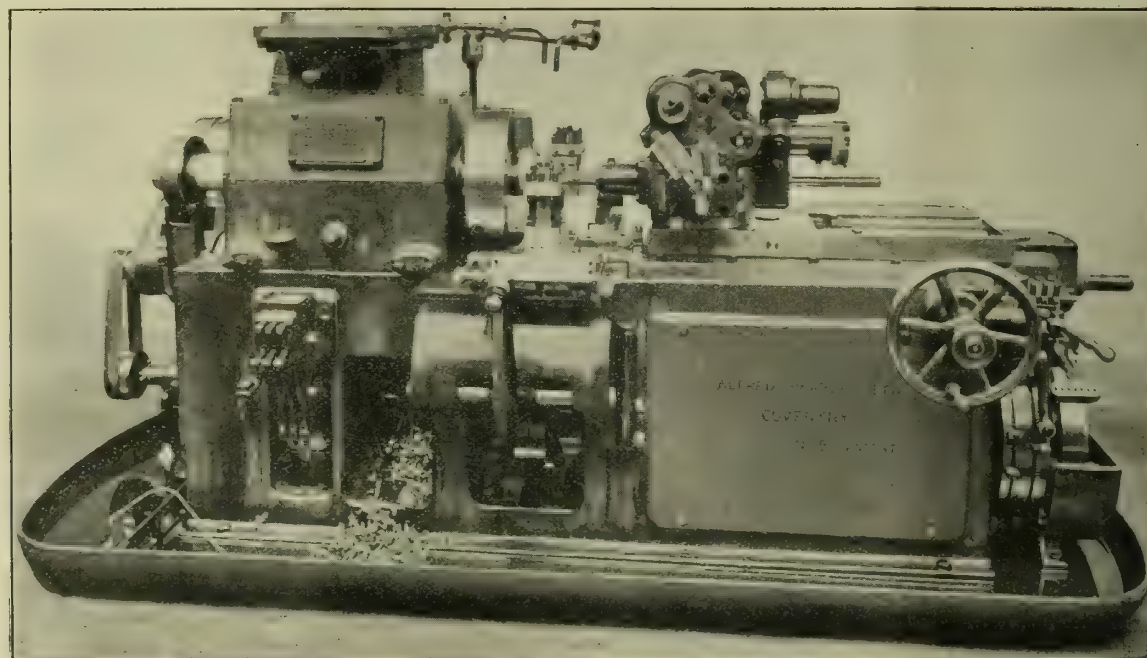


Fig. 3.

adjustable along the bed for a length of 6 in., and the turret slide has a working stroke of 13 in., and the turret is indexed in the extreme back position and clamped automatically. It is square, and its flat faces are accurately surfaced so as to be exactly square with the spindle.

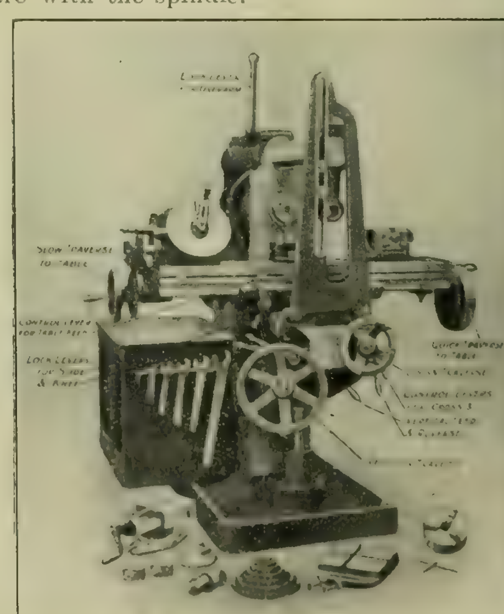


Fig. 5.

The cam is a drum driven direct by worm wheel without torsion. It has two grooves, one for moving the turret slide and the other for indexing. The latter only operates when the turret is in its extreme back position, so that all the working stroke is avail-

able for actual cutting operations. The turret-actuating groove is cut like a screw thread, which returns upon itself and thus moves the turret forward and back with a perfectly smooth and steady motion without irregularity or jumping, even while taking very heavy cuts. For each complete forward and return movement of the turret the cam makes three complete turns.

The front and back cross slides are independent and are independently adjustable along the bed. They can be set to work either at the same time or separately as required. They can thus be set to take

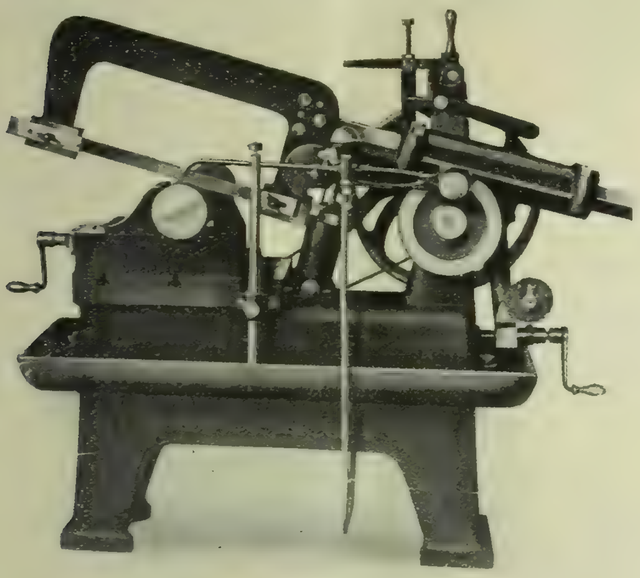


Fig. 6.

rough and finish facing cuts simultaneously. The cross slide cam discs can be set round to any part of the cycle of operations.

The single pulley runs on ball bearings and drives the head by a friction clutch, which can be engaged or disengaged by a hand lever for starting and stopping the machine. It has a hollow spindle which is flanged at the nose to carry the chuck. It runs in white metal bearings and has a ball thrust. The automatic speed change operates instantaneously and silently, and can take place if necessary while the tools are cutting. The ratio of change can be varied as required by means of change gears. The change gears furnished with the machine provide five ratios of automatic change for each of the six substantive spindle speeds, while additional speeds can be obtained by additional change gears.

The spindle can be stopped automatically at any instant as, for example, at the end of a cut, enabling the tools to be withdrawn, without leaving a spiral mark on the work. The spindle restarts automatically in time for the next tool.

"Auto lathes" are, of course, specially useful for dealing with articles made, not from the bar, but from detached pieces, which may be castings, forgings, or blocks previously cut off. The articles are chucked by hand, all the other operations being automatic, including the stopping of the machine at the completion of its cycle of operations.

It is found in practice that an operator can attend to about the same number of auto-lathes as of automatic screw machines, in spite of the fact that the chucking is done by hand, the reason being that the time for producing each article averages rather longer for chuck work than for bar work, on account of the larger diameters of the castings or forgings dealt with necessitating the running of the whole machine at a lower speed than an automatic screw machine, and thus allowing the attendant plenty of time to get round to each machine in time for the chucking.

Messrs. A. Herbert show some of the finest machines in the exhibition, another very fine production being their No. 13 hexagon turret lathe. It is claimed that this lathe represents the very latest practice in turret lathe design, incorporating every known feature to ensure speed and accuracy.

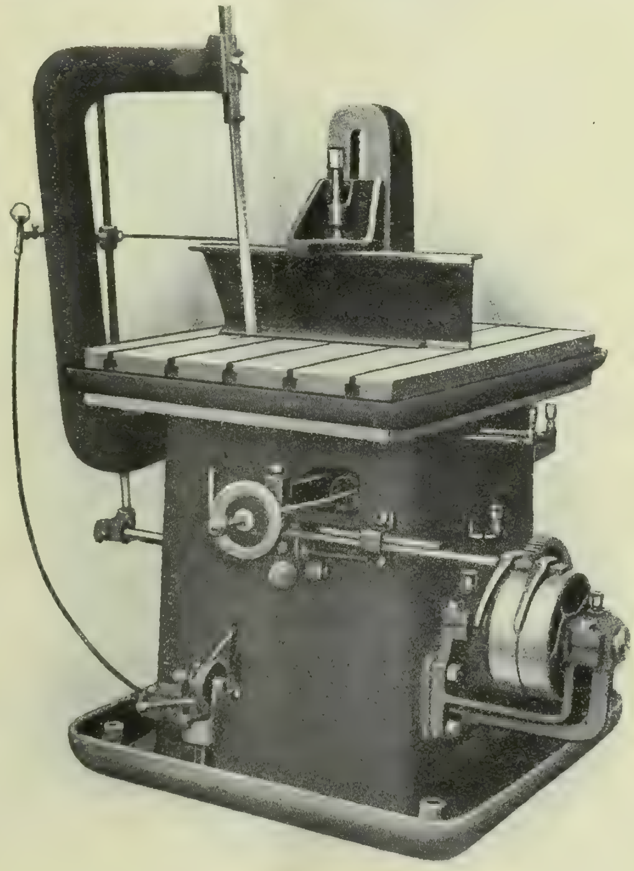


Fig. 7.

Messrs. J. Parkinson & Son.

This firm specialises in milling machines. Fig. 4 illustrates their No. 28 miller, and Fig. 5 clearly shows the control features arranged for convenient manipulation by the operator.

The universal dividing head is arranged for rapid or direct, plain, and differential indexing, and also for spiral cutting. The spindle has a $1\frac{1}{16}$ in. diameter hole through, and the dividing or worm wheel is unusually large in diameter. The worm is hardened and ground, and both wheel and worm are fully enclosed. The worm is adjustable for wear, and is conveniently disengaged from the wheel to permit direct indexing, which is effected by a plunger directly engaging holes drilled in the worm wheel.

The dividing plate used for plain indexing is drilled on both sides and enables all divisions up to 60, all even numbers, and those divisible by 5 up to 120, and divisions mostly used up to 400 to be made. Other divisions may be obtained by differential indexing.

A special feature is the method of driving the feed independently of the spindle, by which the capacity to remove metal is greatly increased. A simple and effective automatic device prevents the feed operating when the cone pulley is not running. The spindle is of nickel steel; its front flange is a standard diameter, and has four holes drilled and tapped for clamping large face milling cutters direct to the spindle. Hardened steel keys fitting in slots in the spindle act as positive drivers for such cutters, and for arbors. The countershaft is of compact gear-box type, with two forward and one reverse speed; the gears run in oil, and the bearings are self-oiling. The speed changes are easily made, and only one belt is required from the line shaft to the countershaft.

All feeds have large diameter dials, graduated to read to ·001 in., and the power feeds are provided in all directions at 12 rates, ranging from ½ in. to 10·4 in. per minute, irrespective of spindle speed, thus meeting the requirements of high speed with slow feed for small cutters, and slow speed with fast feed for large cutters, and all feeds may be started, stopped, and reversed by the operator, either from the front or the side of the machine. The feed gear box is claimed to be "foolproof," and all changes can be made when running at any speed, without damage. Automatic lubrication is provided.

Messrs. E. G. Herbert Ltd. and E. H. Druce & Co. Ltd.

Both these firms exhibit metal sawing machines of robust construction, and designed in accordance with the most modern practice. Fig. 6 is a "Druce" saw of 6 in. by 6 in. capacity, but larger sizes are made with a capacity of 14 in. diameter. These machines are provided with automatic lift for the saw on the return stroke, and a special device for adjusting the pressure on the saw blade. An adjustable stop is also provided for automatically stopping the machine at any depth of cut. Each machine is supplied with a heavy screw vice with swivelling motion for angular cuts, suds pump, tank, tray and fittings, spanner handle and one blade, and the drive is by fast and loose pulleys with suitable belt striking gear.

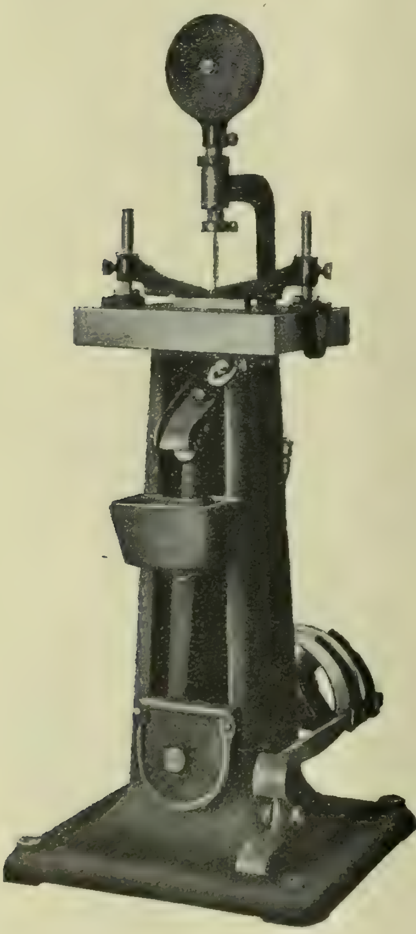


FIG. 8.

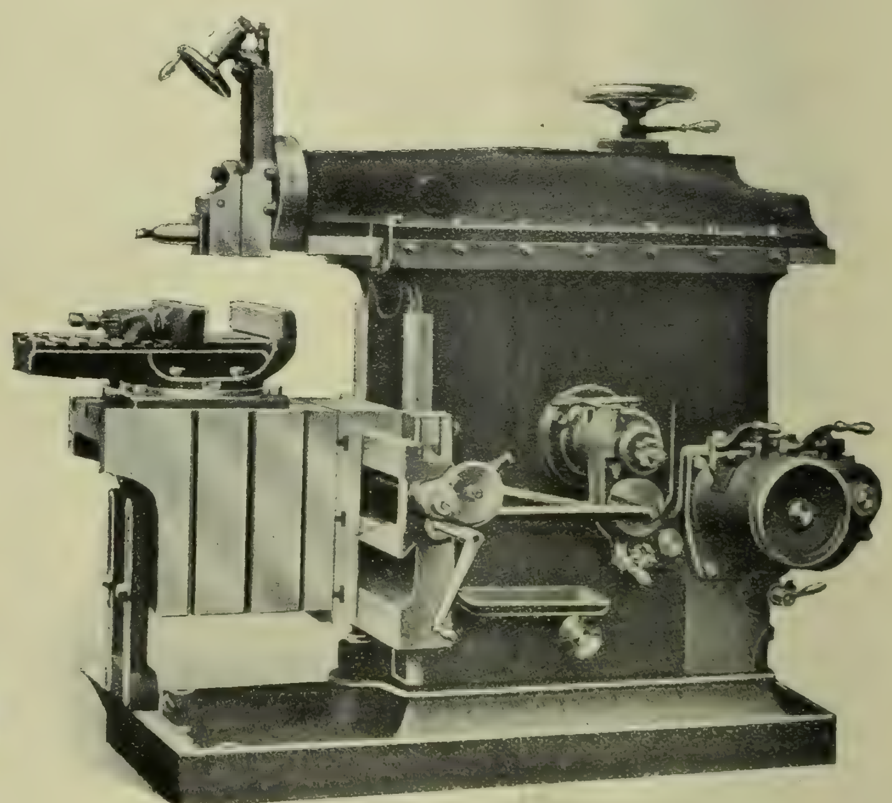


FIG. 9.

Fig. 7 is a different type of sawing machine made by Messrs. Herbert. It is a vertical of heavy and powerful design, adapted for a large variety of work formerly done by slotting or other expensive methods. The table has a working surface of 42 in. by 30 in., and is mounted on a slide with screw adjustment. The saw has an automatic feed by adjustable spring pressure, with oil dashpot to prevent violent movements. The feed movement of the saw is 14 in. at the table level, and by employing the table slide, cuts 26 in. long can be made at one

setting. The saw frame is set at an angle of 45 deg. to the plane of the saw blade so as to clear the work in either transverse or longitudinal cutting, and this enables a long bar or girder to be cut in two transversely or longitudinally. The machine will cut through a bar 9 in. diameter or bevel a 12 in. joist at any angle. It will cut the flange off a joist. It is equally applicable to cutting out connecting rod ends or crankshafts, notching and trimming plates and slabs and other difficult operations.

A very handy machine in many shops is the Herbert machine shown in Fig. 8. It is specially designed for sawing out dies, metal patterns, and

Fig. 10

sheet templets, and file holders are supplied with each machine to enable the work to be finished by filing. The table is 15 in. square and can be tilted 10 deg. either way, so that dies can be cut with the necessary clearance. A work stay is provided and can be placed in various positions to suit the work dealt with. The saws will cut any material from brass to tool steel. They are supplied in coils which fit in the magazine above the saw frame. The holders take saws up to ⅝ in. wide. The saws should be set with a rake of about ⅛ in. to increase the cutting action and allow the blade to clear the work on the up stroke. The stroke is adjustable from 0 in. to 4 in. The height from table to saw holder, with saw frame in lowest position, is 3 in. on the maximum stroke. The main slide is square, sliding in a long bearing adjustable for wear. The connecting-rod ends are adjustable for wear.

Crossley & Co.

This well-known Manchester firm show several drilling and tapping machines. The automatic spur gear generating machine on their stand, which is made by Messrs. Wm. Muir & Co. Ltd., under "Melloy-Owen" patent, is claimed to surpass any other machine on similar work in speed by 50 per cent. It introduces a new development, the generation of heavy cast-steel chain sprocket wheels for tractors.

The shaping machine (Fig. 9) is claimed to embody several unique features. The body, which has a dish round the base to catch lubricant, cuttings, etc., is arranged so that keyways may be cut in long shafts. The front of the base acts as a slide for the table support which is supplied with the larger sizes of machines. The ram has square guides and adjusting plates, and the adjustment is by hand wheel, rack and pinion. The locking lever for the ram adjustment is placed immediately below the adjusting hand wheel. The ram is driven by link and connecting-rod, giving a draw motion to the ram tending to ensure smooth cutting. The stroke index is stationary, and, being fixed just over the handle for adjusting the stroke, it is always in sight. It can be adjusted either when the machine is running or at rest, which enables the operator to adjust the stroke before starting the machine, and the tool head is arranged to swivel slightly on either side of the vertical position. The gear-box, which is fitted to the larger sizes, gives eight speeds. There are no friction clutches or idle running gears in the box.

Another fine machine of the Crossley firm is their 18-in. sensitive drilling machine, shown at Fig. 10, which will bore a 1-in. hole 6 in. deep when fitted with ball bearings throughout. The rack sleeve for the spindle is made of steel, and is graduated for gauging depths of holes. It is also provided with an adjustable stop, and there are four speeds ranging from 250 to 1,074. The sliding head is balanced, and has a reliable locking device.

David Brown & Sons Ltd.

In all matters appertaining to gearing and gear cutting this firm is prominent, and Figs. 11 and 12 represent their latest model of worm wheel generator. This machine will cut worm wheel blanks to gear at centre distances varying from 3 in. to 6 in. The various levers and handwheels are conveniently placed for the operator, and because of the angle of the hob slide vibration is stated to have been eliminated. All the downward thrusts are carried by a large diameter cone bearing. The drive is taken direct from the main gear box to the hob arbor without passing through any intermediate dividing change gears, thus enabling the hob to be run at a predetermined speed independently of the ratio of the gears being cut.

All the change gears are provided with solid keys to prevent any possibility of the latter accidentally dropping out of position during setting up. All studs carrying change gears are provided with solid pin projections, which engage with slots on locking washers. The latter are thus prevented from rotat-

ing or coming adrift, even should the change gears be rubbing against them in an anti-clockwise direction.

What is very important in a machine of this type is that the drive to the work table can be disconnected, thus enabling it to be revolved by hand to facilitate setting up, and the work is continuously rotated, thus dispensing with a separate index motion. The hob slide can be moved, and the hob rotated, by hand, into any required position, without affecting the remainder of the machine.

For repetition work the cutter head handwheel can be adjusted to make contact with a stop arranged to come into operation when the cutter head has been fed forward to its correct centre distance. For this purpose the cutter head handwheel is removable, and is provided with an internally toothed gear wheel which engages with a toothed sector rigidly secured to the handwheel shaft. If the cutter head is already set at the correct centre distance, the locking handwheel should be unscrewed, and the large handwheel partially withdrawn, and replaced in such a position that a lug on the side of the wheel is in contact with a plunger projecting from the bed of the machine, thus enabling the cutter head, if moved backwards, to be accurately returned to its original setting. A variation of one tooth on the sector corresponds to a feed of one-thousandth of an inch.

It should be pointed out, however, that as one complete turn of the cutter head handwheel corresponds to a feed of only $\frac{1}{8}$ in., the handwheel generally requires a rotation of several complete revolutions between the mounting of one blank and another. To enable this to be done the projecting "stop" plunger can be moved backwards, so as to clear the lug on the periphery of the handwheel, though obviously it must be brought forward again before the final revolution of the cutter head handwheel is completed. The stop on the cutter head handwheel accurately determines the position of the cutter head, but the stop on rack at the side of the cutter head cannot be used as a means of measurement. It merely serves as a check to prevent excessive feed which might otherwise be possible owing to carelessness on the part of the operator.

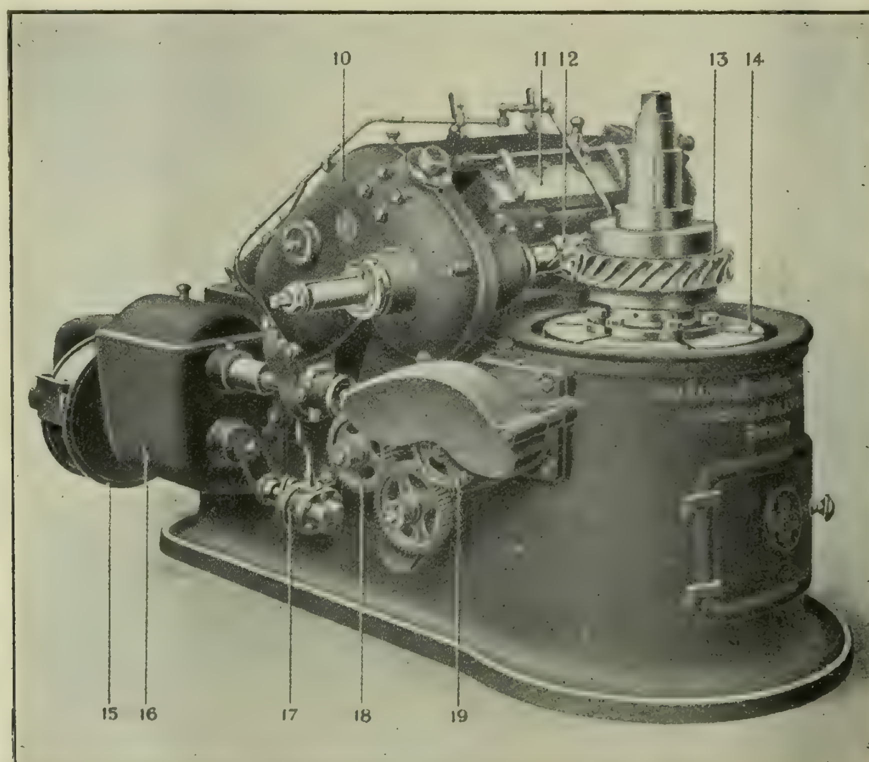


FIG 11.—Left-hand View of Machine.

10. Cutter head.
11. Hob slide.
12. Hob.
13. Worm wheel blank.
14. Work table.
15. Main driving pulley.
16. Main drive gear box.
17. Pump.
18. Driven dividing change gear.
19. Driving dividing change gear.

The Skefko Ball Bearing Co. Ltd., Luton.

An interesting display is to be seen at stand No. 15. To demonstrate the various controls through which the SKF ball bearings pass, before being finally passed for sale, a model control has been erected, where operators conduct the gauging and tests for accuracy, hardness, etc., that are employed in the ordinary course of manufacture. Two interesting models are on view. The first is an electrically-driven machine which throws up small steel balls and causes them to bounce on a steel anvil. The resiliency of the balls and the accuracy with which they continue to bounce on the same spot, testify to the efficiency of the hardening, and the true sphericity obtained in manufacture. The other model

consists of two 8-in. balls, one of which revolves at 600 revolutions per minute. So accurate are the sphericity and finish of these balls that it is impossible for the spectator to distinguish between the revolving one and the stationary. In addition to the SKF self-aligning ball bearings, a new production, the SKF self-aligning roller bearing is shown for the first time. This bearing is a departure from the ordinary roller bearing design, and should prove of considerable interest. This new roller bearing, it is claimed, has achieved immunity from many of the faults inherent in ordinary roller-bearing construction.

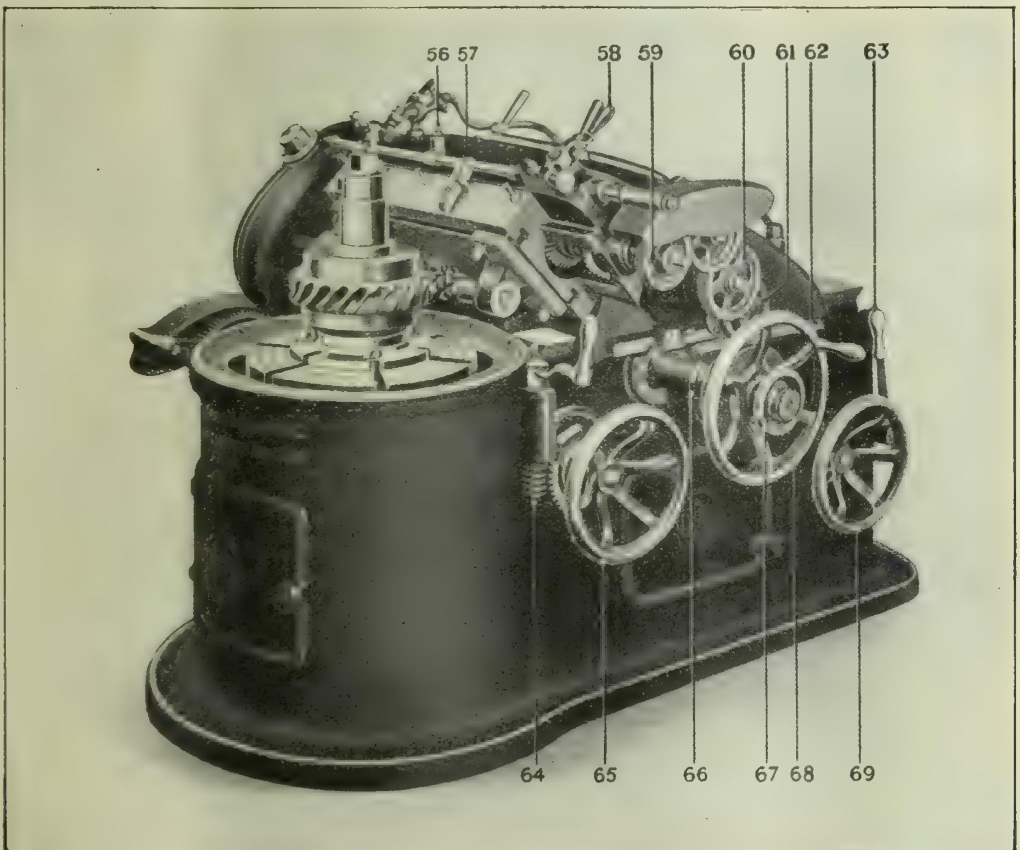


Fig. 12.—Right-hand View of Machine.

56. Hob slide trip dog.
57. Hob slide trip arm.
58. Hob slide trip lever.
59. Driving differential change gear.
60. Driven differential change gear.
61. Change feed handwheel.
62. Cutter head vernier scale.
63. Starting lever.
64. Cradle disengaging worm.
65. Cradle locking handwheel.
66. Cutter head micrometer.
67. Locking handwheel.
68. Cutter head handwheel.
69. Change speed handwheel.

A section of the stand is devoted to SKF split belt pulleys. Great ease in fitting is claimed for this pulley, whose original design cuts down weight to a minimum, as well as providing for the interchange of rims and shaft bushes of various sizes, and the use of ball-bearing inserts for loose pulley work.

Burton, Griffith & Co. Ltd.

The "Oerlikon" automatic bevel gear planing machine (Fig. 13) on this stand is of new design. It is very solid and substantial, and, because of its rigidity, is able to work at high speed on hard material. As compared with the generating machine, one advantage of using the "former" is that it is frequently necessary to vary slightly the contour of the teeth to suit special conditions of working. On this machine the mounting of the "former" is comparatively easy, and adjustments can be quickly made, and by an ingenious arrangement one "former" is only necessary instead of two, consequently reducing the number of "formers" required. The "former" is made several times larger than the actual tooth, and to the shape of one side or half of the tooth to be produced.

The machine is constructed so that cuttings or chips cannot interfere in any way with the slides of the tools, or with the gearing operating the travelling headstock, a defect which is prominent on some machines. The tools are very simple and require no excessive care in sharpening. A special arrangement obviates any liability of the tools engaging with the work, whilst the indexing of the blank is proceeding, and no advancement of the tools can take place until the indexing is finished. The gearing is very simple, and the machine can be changed from one number of teeth to another in about 15 minutes.

Charles Churchill & Co. Ltd.

The Vickers patent broaching machine on this stand possesses some distinctive features. The body of the machine consists of two main castings having

a fitted joint on the centre line of the screw. Within this body runs the whole of the gearing immersed in oil, which is also arranged to automatically lubricate the high-speed bearings. The guide-way is of "U" section and of ample proportions to ensure strength, the base being spigoted and securely fastened to the main body. The front end is supported from the floor by a cast column arranged to effectively drain and return all cutting lubricant to a reservoir contained in the main body of the Nos. 1, 2 and 3 machines. In the Nos. 4 and 5 machines the reservoir is a separate rectangular box. In all the sizes the reservoir is easily accessible for cleaning purposes. The lubricant is circulated by a rotary force pump of large capacity with relief valve and strainer, the jet being conveniently arranged at the front of the machine.

The large crown gear transmitting power to the cutting stroke is supported by and runs in a bronze-lined bearing. The pinions in mesh with this, together with all the change gears, are of steel, machine cut. The whole gear train applies to the cutting stroke only, consequently it is never reversed, but is driven by a constant-speed single pulley in one direction.

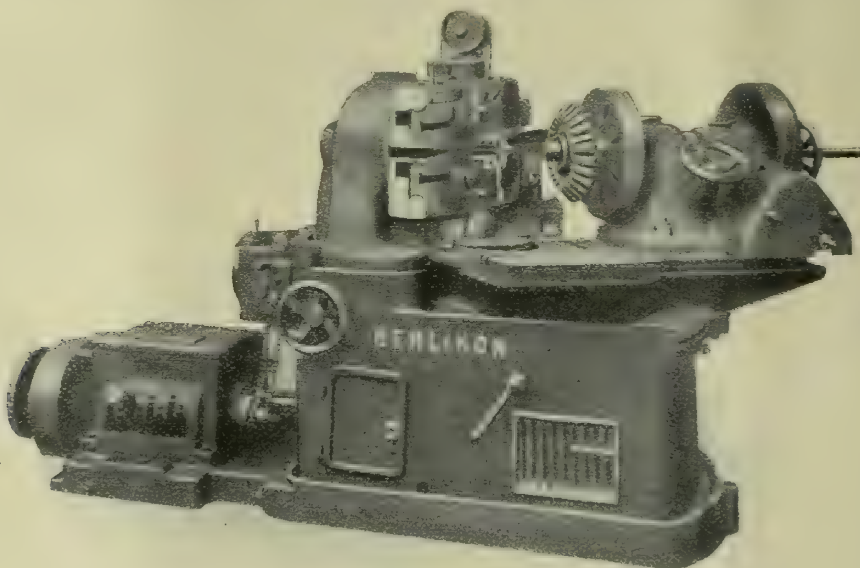


FIG. 13.

The thrust bearing is of the roller-bearing type, with a factor of safety which the power of the machine cannot exceed.

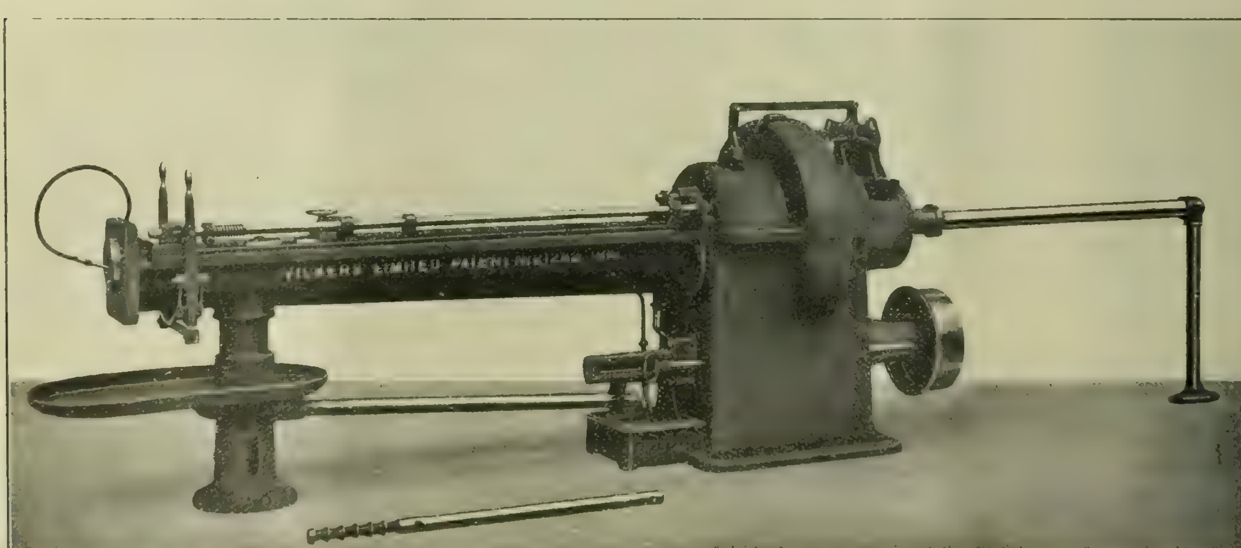


FIG. 14.

AUSTRALIAN COAL: SALES TO SWEDEN. One hundred and forty thousand tons of coal have been sold to Sweden at 22s. 6d. per ton, plus £8 for freight charges from Newcastle. Delivery is to take place during the current half year.—Reuter.

Trade Items, Notes, &c.

We are informed that Mr. S. Ronald Barclay, A.C.I.S., has resigned his position with the Buenos Ayres Great Southern Railway Co. Ltd., upon his appointment as secretary to Automatic and Electric Furnaces Ltd., 281-283, Grays Inn Road, W.C.1.

DRILLING FOR BRITISH PETROLEUM.—According to a report just issued by the Petroleum Department, substantial progress has been made during the past six months in the development of the petroleum resources of the United Kingdom. A great depth in drilling has been achieved at West Calder, in Scotland, where a depth of 3,844 feet has been attained. This figure has been exceeded at Ironville, at No. 2 well, but it is standing at 4,006 feet pending results from a neighbouring well. At Hardstoft, in Derbyshire, production by natural outflow is reported at the rate of seven barrels a day, and the quantity of oil in stock to the end of August amounted to 3,696 barrels, or 478 tons. Between December 31, 1919, and August 31, 1920, the aggregate progress made in drilling at the ten wells in Derbyshire, North Staffordshire and Scotland amounted to 5,202 feet.

AIRCRAFT DISPOSAL COMPANY.—This company inform us that they have a vast assortment of useful parts, fittings and materials available for immediate delivery to engineers and manufacturers at the present time. The British Government disposed of the whole national stock of aircraft accessories, and material necessary for the manufacture of every kind of flying machine. The stock includes nuts, flynuts, bolts, washers and screws of various dimensions, and it should be noted that all threads are B.S.A. Ball bearings range from $\frac{1}{8}$ to four inches in diameter. The firm state that they have assorted sets of bearings complete and ready for fitting to shafts of every useful diameter. There is much material useful to printers' engineers. An enquiry addressed to the company at Regent House, Kingsway, W.C., will result in a notification of the nearest material available for prompt delivery.

COMBINING COMMERCIAL MOTOR USERS.—During the Commercial Vehicle Show to be held at Olympia, from October 15 to October 23rd, the Commercial Motor Users' Association will organise a meeting of motor coach proprietors with the object of gathering all local organisations into one body, and forming a national association, with local branches, of course. It is stated that in various parts of England, the motor coach plies on practically every route that connects outlying villages to the nearest towns, and any centre that can be regarded as a focus point for holiday makers is provided with these vehicles which range the district for about 40 miles round. In these districts most of the licensing rules and regulations vary, and one object of combining the motor owners in London and the provinces is to try and procure something like uniformity in the licensing regulations.

APPROVED RESEARCH ASSOCIATION.—The following is a list of Research Associations which have been approved by the Department of Scientific and Industrial Research, as complying with the conditions laid down by the Government scheme for the encouragement of industrial research, and have received licences from the Board of Trade, under Section 20 of the Companies (Consolidation) Act of 1908: The British Iron Manufacturers' Research Association, Atlantic Chambers, Brazennose Street Manchester: Secretary, Mr. H. S. Knowles. The Research Association of British Motor and Allied Manufacturers, 39, St. James's Street, London, S.W.1.: Secretary, Mr. Horace Wyatt. The British Scientific Instrument Research Association, 26, Russell Square, W.C.1: Secretary, Mr. J. W. Williamson, B.Sc. The British Non-Ferrous Metals Research Association, 29, Paradise Street, Birmingham: Secretary, Mr. E. A. Smith, A.R.S.M., M.Inst.M.M. The British Refractories Research Assosciation. The Scottish Shale Oil Research Association.

MOUCHEL-HENNEBIQUE.—There is much diversity of opinion about the merits of ferrô-concrete. It is condemned by many as inartistic, but, if so, Messrs. Mouchel & Partner Ltd. must be congratulated in presenting a brochure which is a list of works executed in the United Kingdom, and beautifully illustrated. The use of ferro-concrete for the construction of ships is yet, we think, in an experimental stage, but not so for buildings. There is no reason why a ferro concrete structure should not be as pleasing to the eye as one of stone or brick, and the material has the merits of cheapness and of strength. Altogether, during the past 25 years 20,633 buildings of all kinds have been made of ferro-concrete; 4,182 bridges and viaducts, besides a large number of underground structures, reservoirs, etc. Sea barges have also been built, and at least one cargo ship, the "Armistice," of 1,150 tons deadweight capacity. The brochure is an interesting record of work accomplished. The firm's address is 38, Victoria Street, Westminster, S.W.1.

GREAT WESTERN RAILWAY'S SUGGESTIONS SCHEME.—Nearly seven years ago a Suggestions Scheme was initiated by the General Manager of the Great Western Railway. As showing how favourably the scheme was received on its first inception, it may be mentioned that, during the first six months, no fewer than 675 suggestions were submitted, and the years totals from that time have been 994, 1,106, 1,013, 1,031, 1,544, and 1,096 respectively. Encouraging the submission of ideas, the directors have now agreed to award four special prizes of £25 for the best suggestion adopted under each of the following headings during the year ended March 31, 1921: (1) Traffic arrangements, commercial and operating; (2) mechanical and engineering appliances; (3) signalling and signalling appliances; (4) miscellaneous (including office methods and organisation). The prizes will be in addition to any gratuities awarded in the ordinary course for such suggestions as the committee may recommend for adoption, and the existing method of dealing with suggestions generally will continue. All suggestions submitted are carefully considered by the Suggestions Committee.

LONDON-MANCHESTER CABLE.—The new cable being laid between London and Manchester will provide three times the number of trunk lines of the cable laid in 1915 between London and Liverpool, and in other ways it provokes some interesting comparisons. The average weight per wire per mile in the old cable is 146 lb., as compared with 40 lb. in the new cable. It will contain altogether 160 pairs of copper wire, of which 104 pairs will be used as telephone trunk lines, and 56 pairs for telegraphic purposes. Each wire weighs 40 lb. per mile, and the construction of the cable required $5\frac{1}{2}$ tons of cable for each mile laid. By passing the circuits through telephone receivers at Derby, not only will speech be rendered possible, but in volume and clearness it will be equal to speech heard from a few miles away. Before the invention of the repeater six or seven lines of poles, carrying overhead wires, each weighing 2 cwt. per mile, would have been necessary for the same number of "lines." The London to Liverpool cable contained 52 pairs of wires, varying in weight from 100 lb. to 300 lb. per mile, and the total weight of copper for the 104 wires weighed seven tons per mile.

The Department of Scientific and Industrial Research has now established four sub-committees to assist the Radio Research Board in the investigation of certain problems in connection with the work of the Board. The constitution of the Board and its sub-committees is at present as follows: Radio Research Board Admiral of the Fleet Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S. (Chairman); Commander J. S. C. Salmond, R.N. (representing the Admiralty); Lieut.-Col. A. G. T. Cusins, C.M.G., R.E. (representing the War Office); Wing Commander A. D. Warrington Morris, C.M.G., O.B.E. (representing the Air Ministry); Mr E. H. Shaughnessy, O.B.E (representing the General Post Office); Professor Sir J. E. Petavel, K.B.E., F.R.S., (representing the National Physical Laboratory); Professor Sir Ernest Rutherford, F.R.S.; Professor J. S. E. Townsend, F.R.S. Sub-committee A on the Propagation of Wireless Waves, Dr. E. H. Rayner, ScD. (Chairman); Professor E. H. Barton, D.Sc., F.R.S.; Major J. R. Erskine-Murray, D.Sc.; Professor H. M. MacDonald, F.R.S.; Professor J. W. Nicholson, D.Sc., F.R.S. Sub-committee B on Atmospherics: Colonel H. G. Lyons, D.Sc., F.R.S. (Chairman); Mr. A. A. Campbell Swinton, F.R.S.; Professor S. Chapman, F.R.S.; Major H. P. T. Lefroy, D.S.O., M.C., R.E.; Mr. G. L. Taylor, F.R.S.; Mr. R. A. Watson Watt; Mr. C. T. R. Wilson, F.R.S. Sub-committee C on Directional Wireless: Mr. F. E. Smith, O.B.E., F.R.S. (Chairman); Mr. N. P. Hinton; Captain C. T. Hughes, M.C., R.E.; Captain J. Robinson, M.B.E., R.A.F. Sub-committee D on Thermionic Valves: Professor O. W. Richardson, D.Sc., F.R.S. (Chairman); Mr. E. V. Appleton; Captain S. Brydon, R.E.; Captain H. L. Crowther, R.A.F.; Professor C. L. Fortescue, O.B.E.; Mr. B. Hodgson, M.Sc.; Professor F. Horton, D.Sc.; Major A. G. Lee, M.C., R.E.; Mr. H. Morris Airey, C.B.E., M.Sc.; Mr. R. L. Smith-Rose; Professor R. Whiddington, D.Sc.

American Engineering News.

[By Our Own Correspondent.]

The bureaus of the different departments of the Government prepare valuable reports covering a wide range of subjects. These, until Congress became parsimonious with appropriations, were distributed free to anyone who asked for them. Nowadays they are sold at cost. Two such publications just out are :—

(1) "A Glossary of the Mining and Mineral Industry." Compiled by A. H. Fay. 753 pp., bound in cloth, price 75 cents. Contains more than 20,000 terms and nearly 30,000 definitions, covering technical anl local usage in mining and metallurgy, including terms used in coal mines and coke ovens, oil and gas wells, metal mines and metallurgical works and quarries, as well as geological and mineralogical terms, and more than 2,000 Latin-American mining terms. Many obsolete terms are defined.

(2) "Manganese; Uses, Preparation, Mining Costs, and the Production of Ferro-Alloys." By C. M. Wild and others, 209 pp., 13 figs., price 30 cents.

Havana might be better equipped as a port, which partly accounts for the prolonged congestion which has very seriously interfered with shipping operations between that harbour and ports in this country. For that reason, and because Cuba is a sort of foster child of ours, the President of Cuba has appointed a committee to co-operate with a committee from the United States to confer over conditions and find a remedy. This was announced by our State Department on August 4th.

Josephus Daniels, our Secretary of the Navy, said on August 4th, upon his return from Alaska, that he expected Alaskan oil lands eventually to yield a large part of the oil supply necessary for the Pacific fleet. Mr Daniels also said that coal deposits totalling between 400,000 and 500,000 tons are already in sight in the Navy's coal reserve lands in Alaska, with good prospects for a very much larger supply. And this whole territory of Alaska was bought from Russia for a few paltry millions of dollars.

Explosions in grain elevators and mills cost American industry over 6,000,000 dols. during the 20 months ending October, 1917, and resulted in the loss of 24 lives and 36 persons severely injured, according to a report of the U.S. Department of Agriculture.

A single explosion of dust in a corn starch factory cost 3,000,000 dols. and 43 lives, while last February six girls were killed and five others badly injured in an aluminium goods factory by an explosion of dust.

These and other appalling disasters set the Bureau of Chemistry to work in an attempt to cure the evil. A report on the subject says "that dust will explode is no longer a scientific theory; it is a hard, established fact and a condition which must be anticipated." The methods employed by the Bureau to prevent explosion in the handling of the gigantic stores of grain by the Government during the war are described in a bulletin just issued. They are both simple and efficient. Workmen and employers have been asked to send for copies of the bulletin, which is free, to enable them to co-operate in preventive measures..

A forceful concluding paragraph reads :—"And you, Mr. American Ultimate Consumer, might ask for a pamphlet too, and find out how much your annual tax for these strange fireworks amounts to. One explosion ruined grain enough to feed an army of 200,000 for a year—and you pay more for your loaf because of it. Find out what you can do to encourage the work so well begun."

This does not read much like a formal Government document. But to use an Americanism "It gets" the public interested, and that after all is the mark aimed at.

On the 28th of July the American Locomotive Company booked orders for 50 locomotives from one American Railway Company, The Chicago Northwestern. On the same day orders for 25 engines for foreign account, 10 of these being for Cuba and 15 for Argentina.

For many years a chronic complaint was heard here that our locomotive engines did not stand the gaff when set to work alongside those of European make. Of late, however, exports have been numerous. This, and the large number sent from here to the front during the war should settle that question very definitely. The pudding is in process of mastication.

A recent compilation shows that there are nearly a million motor trucks in use in this country. The State of New York leads with 94,716 trucks; Illinois ranks second with about 65,000, while Pennsylvania and Ohio run very close with 64,200 and 64,500 respectively. One authority, commenting on the fact that for the year trucks showed a larger increase than passenger cars, points out that if trucks continue to increase at the same rate in the future there will be as many in use in 1926 as there are passenger cars at present.

While the greatest increase in the use of trucks was shown by manufacturing districts, their use on farms showed large gains. A recent Government report gives 49,195 as the number of motor trucks in use on farms, adding that their use is steadily increasing.

It is estimated that this country originally possessed 850,000,000 acres of timberland, of which only 545,000,000 acres remain. However, in spite of criminally wasteful methods, only Canada and Russia have a larger supply remaining.

In 1906 we produced 46,000,000 M feet, dropping to 32,000,000 M feet in 1918.

The production of yellow pine is rapidly diminishing. In 1916 approximately 15,055,000 M feet were cut, while during 1918 only 10,845,000 M feet were taken out.

The centre of the industry is constantly shifting. Twenty years ago Wisconsin, Michigan and Minnesota were the leading timber-producing states. Now Washington, Louisiana and Oregon produce jointly about one-third of the total lumber output of the country. It should not be forgotten that the United States is the largest wood-using country in the world, the great majority of dwellings and farm buildings being built of wood. We also import considerable quantities, the 10-year average to 1919 being in round figures 1,250,000 M feet.

While our timber exports over a period of years from 1910, before the U.S. entered the war, averaged some 2,221,000 M feet, they were comparatively small compared with the total average cut of 43,300,000 M feet over the same period. Four per cent of the country's sawmills produce 60 per cent of the total output. These mills are each rated to produce 10,000,000 ft. and over per annum.

The per capita consumption of timber in this country has steadily declined since 1906, when it was 516 ft. For 1918 the per capita consumption had fallen to 300 ft.

Unless a far-sighted national policy of reforestation is put into practice, the end of American timber is in sight. However, according to Henry S. Graves, formerly chief of the United States Forest Service, if we began at the present time to protect our cut-over lands from fire, and use wholly practical forestry methods to ensure reproduction after logging, we could secure in the next 50 or 60 years an annual production of over 60,000,000 ft. of timber per year without lessening our forest capital.

America's great national sin has been, and is, *waste*. Let us hope we will repent of this one, and do a profitable penance.

Despite all the propaganda and newspaper talk about an American merchant marine, we have not really a national salt-water conscience. Our war-built shipyards are being abandoned one after another. Our shipbuilders admit that lower prices for tonnage will soon rule. Just at present quotations range between 150 dols. to 160 dols. per ton, with no takers. Prospective buyers are holding off for 135 dols. a ton or less.

The number of "lame ducks" among our war-time built ships is too large to warrant fancy prices, according to those who ought to know. This attitude is patriotically resented; nevertheless, the record stands for all to see. The Shipping Board wants to get rid of its tonnage, but is between the devil and the deep sea, what with indifferent potential purchasers and ship builders who fear bargain prices will cripple them. Then again, there is the question and a serious one at that as to what retaliatory measures other nations may adopt to counteract our recently enacted so-called "Jones" shipping law.

One-way cargoes spell bankruptcy, and besides construction for the Shipping Board has been dwindling from month to month, while June showed the first decrease in tonnage contracted for by private companies. As a matter of fact, the only new business that came to our shipyards in June was for two tankers.

Our legislators seem to overlook the obvious fact that their supreme authority ends at the three mile limit. Beyond that, the other fellow has something to say.

New Companies.

London Galvanised Iron Co. Ltd. Private company. July 12th. Capital, £20,000. Mrs. M. A. Mellor is first governing director. Solicitor: G. D. Harrison, Vernon House, Bloomsbury Square, W.C.

London Structural Co. Ltd. Private company. July 10th. Capital, £30,000, £1 shares (15,000 preference). Engineers and contractors, etc. Directors: F. A. Norris and A. M. Bowley. Registered office: Stuart House, Tudor Street, E.C.4.

South Wales Colliery Tram Works and Engineering Co. Ltd. Private company. July 12th. Capital, £5,000. Permanent directors: T. Jones, T. J. Jenkins, and C. Jenkins. Registered office: 6, High Street, Pontypridd.

North Western Engineering Co. Ltd. Private company. July 10th. Capital, £20,000. Directors: C. W. Pickering, J. W. A. Potts, A. E. Hodgson, C. W. Watson, and J. E. Singleton. Registered office: 167, Lord Street, Fleetwood, Lancs.

Oxford Motor Carriers and Repairers Ltd. Private company. July 14. Capital £5,000. Directors: A. W. Bayliss, W. T. Bayly, J. W. Blay, S. H. Bushnell, C. Gurney, and W. E. Wilmer. Registered office: 55, Magdalen Road, Oxford.

Stoke Newington Ex-Service Engineering Co. Ltd. Private company. July 14th. Capital, £100, 2s. 6d. shares. Directors: F. J. Billen and S. C. Maxfield. Registered office: Leswin Place, 24, Leswin Road, Stoke Newington.

Surridge's Patents Ltd. Private company. July 15th. Capital, £15,000. Motor accessories manufacturers, etc. Permanent directors: R. Surridge, senr., and R. Surridge, junr. Registered office: 73, Church Street, Camberwell, S.E.5.

Parkinson & Sharples Ltd. Private company. July 15th, by Jordan & Sons Ltd. Capital, £3,000. Motor engineers, repairers, motor haulage contractors, etc. Directors: A. Parkinson, G. Parkinson, and R. E. Sharples. Solicitor: J. B. Knowles, 38, Richmond Terrace, Blackburn.

Rickard, Wright & Dean Ltd. Private company. July 14th. Capital, £4,500, in 4,000 10 per cent cumulative preference shares of £1 and 10,000 ordinary shares of 1s. each. Electricians, electrical and mechanical engineers, etc. Directors: E. Rickard, W. H. Dean and A. Wright. Registered office: 17, Neal Street, Bradford.

Robert Hornby & Co. Ltd. Private company. July 13th. Capital, £5,000. Civil, mechanical, electrical, marine and general engineers, etc. Solicitor: E. Stoneham, 37–9, Essex Street, Strand, London, W.C.

Robert Norton Ltd. Private company. July 13th. Capital, £1,000. Milling and general engineers, etc. Solicitor: W. Cook, 59, Gracechurch Street, E.C.

M. Squire & Sons Ltd. Private company. July 17th, by Jordan & Sons Ltd. Capital, £22,500, £1 shares (7,500 preference). Agricultural engineers and machinists, implement, manure, and cake importers and merchants, etc. Permanent managing directors: M., D. E., and J. H. Squire. Secretary: R. E. C. Balsdon, Barnstaple.

Watts, Hardy & Co. (1920) Ltd. Private company. July 14th. Capital, £50,000. Manufacturers of and dealers in railway and other carriages and wagons, locomotives, and rolling stock, etc. Directors: J. Watts (chairman) and A. T. Watts. Registered office: 75, Tyne Street, North Shields.

Vulcan Arc Welding and Transport Co. Ltd. Private company. July 13th. Capital, £10,000 in 1,000 founders' and 8,900 ordinary shares of £1 each, and 2,000 employees' shares of 1s. each. T. A. Morris signs as "director." Registered office: 2–4, Harrington Street, Liverpool.

W. & P. Ltd. Private company. July 12th. Capital, £10,000. Manufacturing engineers and machinists. Permanent directors: H. H. Peel, A. W. Wigram and Major K. D. Taylor. Solicitor: R. Y. Norris, Priestgate, Peterborough.

Heron Engineering Co. Ltd. Private company. July 14th. Capital, £4,000. Engineers, etc. Permanent directors: C. A. T. Oulds, F. Ponton, R. D. Power, R. G. West, and A. W. Sargent. Solicitor: J. A. Ellis, 85, Bexley Road, Erith.

Tyre Shop Ltd. Private company. July 16th. Capital, £5,000. Dealers in motor car tyres and motor accessories, etc. Directors: W. E. Burlock, E. S. Bunch, and H. M. Montefiore. Registered office: 33, Leicester Square, W.C.2.

Fyfe Lumsden Ltd. Private company. July 17th. Capital, £12,000, in 11,500 A shares of £1, and 10,000 B shares of 1s. each. General engineers, etc. Directors: H. L. Martin, J. Hanson, A. F. Nicoll and T. I. Hutton. Office: Lane Ends, Eccles, near Manchester.

Mortgages, Charges, Satisfactions.

Burnley Carriage Co. Ltd.—Mortgage dated August 3rd, 1920, to secure £4,000, charged on certain land and premises, etc., in Burnley. Holders: Richard Stuttard Ltd., Primrose Mill, Burnley.

Gibham Tool Co. Ltd.—Particulars of £1,000 debentures, authorised July 29th, 1920, present issue £400. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Isaac Braithwaite and Son, Engineers, Ltd.—Mortgage dated July 10, 1920, to secure £1,500 charged on the field known as "Town End Close," Far Cross Bank, Kendal. Holder: H. Moser, Kendal.

Thomas Locker & Co. Ltd.—Satisfaction to the extent of £6,600 (full repayment completed), on July 27th, 1920, of debentures dated July 1st, 1913, securing £8,900.

Aluminium Corporation Ltd.—Issue on July 27th, 1920, of £10,000 debentures, part of a series already registered.

Stubbs & Birtwistle Ltd.—Particulars of £1,000 debentures authorised July 1st, 1920; whole amount issued charged on the company's property, present and future, including uncalled capital. No trustees.

Cubitt's Engineering Co. Ltd.—Equitable mortgage, dated July 27th, 1920, to secure all moneys due or to become due from the company to Barclay's Bank Ltd., charged on various properties, Aylesbury.

George Bennett & Co. (Sheffield) Ltd.—Mortgage dated August 6th, 1920, to secure all moneys due or to become due from the company to National Provincial and Union Bank of England Ltd., charged on certain land and buildings in Cornish Street, Sheffield.

Patent Applications.

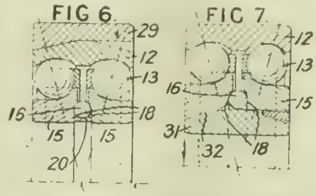
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the lates date possible, and are abstracted from the Illustrated Officia Journal of Patents, which is published weekly.

BEARINGS.

131,744.—C. H. MILLER, 10, Bury Park Road, Luton, Bedfordshire.—Sept. 3rd, 1918.—In a ball bearing having a divided inner race ring, the sections 15 of the ring are spaced apart, after the balls 13 have been inserted, and are adjusted axially to take up wear, by a row of balls 16 placed in grooves 18. The balls 16 may be spaced by a cage or confined by a spring ring 20. The

FIG 6. FIG 7.

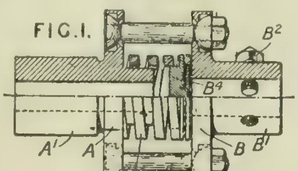


inner or outer ball race surfaces may be spherical or the rings may be seated spherically at 32, Fig. 7, on a sleeve 31. As shown in Fig. 6, the outer race ring 12 has a double conical seating in a housing 29. In a modification, the sections 15 are at first in contact, and balls are only inserted in the grooves 18 when adjustment is required.

HOLDERS FOR REAMERS.

131,986.—T. HINTON, 17, Hampden Road, and H. MERTON, Isomer, The Warren, both in Caversham, Berkshire.—July 31st, 1918.—Relates to reamer-holders for lathes which allow the reamer to assume a position axial to the work. In the example shown,

FIG. I.

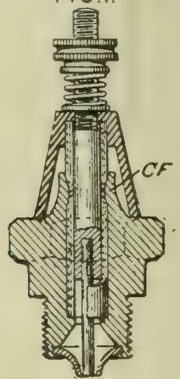


the reamer is secured by a screw B2 in the socket B1 and the part A1 is secured in the turret, etc., of a lathe. The parts A1, B1 have flanges A, B respectively, which are tied together by links C with hemispherical ends and are pressed apart by a spring D, one end of which bears on a disc B4 separated from the disc B by a ball bearing to allow free movement of the disc.

SPARKING-PLUGS.

131,792.—K. E. L. GUINNESS, Aranmor, Kingston Hill, Surrey.—Nov. 5th, 1918.—In order to secure the electrode and its mica insulation in a gas-tight manner, the gland or plug body is provided with an upstanding flange CF which is deformed so as

FIG. I.

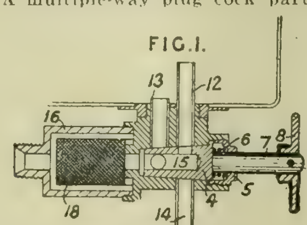


to grip the enclosed parts. Alternatively, the electrode may be partly hollow, the inner end of the hollow portion being conical, so that a ball on being forced in expands the electrode and thereby clamps it in position. The exposed inner portion of the insulation may be protected by a tubular quartz shield.

VALVES.

131,819.—C. W. HIGGS, 47, Brondesbury Villas, Kilburn, London.—Jan. 13th, 1919. A multiple-way plug cock particularly applicable

FIG. I.

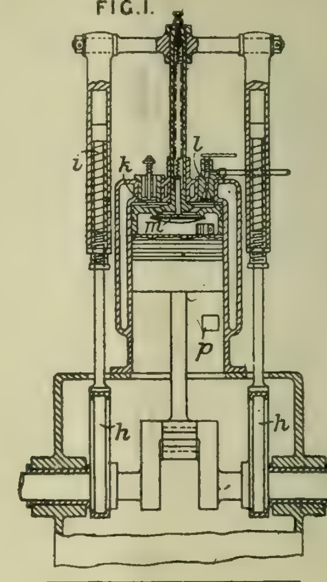


for use in connection with petrol tanks on motor vehicles, has a plug provided with an axial discharge passage 15 and three lateral ports adapted to co-operate successively with two inlet pipes 12 13 of different lengths and with a drain pipe 14. The plug 4 is held to its seat by a spring 6 bearing against a screwed cap 5 and is actuated by a spindle 7 provided with a hand-wheel 8 having markings to form an indicator in conjunction with a pointer on the tank. The outlet is fitted with a filter 18 arranged in a chamber 16.

INTERNAL-COMBUSTION ENGINES.

132,583.—A. M. BOURKE, 329, High Holborn, London.—Mar. 24th. 1919.—Air and liquid fuel are drawn through valves *k*, *l* respectively, into a pump space separated from a combustion chamber by a supplementary piston actuated by eccentrics *h* and telescopic rods fitted with springs *i*. Charges are transferred to the com-

FIG. I.



bustion chamber through a valve *m* in the supplementary piston, which advances at the end of the working stroke of the main position to expel combustion products through a port *p* and draw in a charge behind it. A modified construction is described in which the supplementary piston is connected at its lower end to the connecting-rods.

INDEX TO ADVERTISERS.

[*When enquiring of Advertisers will readers kindly make a "special point" of mentioning* THE INDUSTRIAL ENGINEER.]

THE

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Vol. VIII.] OCTOBER 8, 1920. [Nos. 216.

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Published twice monthly, on the 8th and 22nd days, respectively.

All communications intended for insertion in the Industrial Engineer, *or relating to Editorial matters, should be sent addressed to " The Editors," at our Office, 121, DEANSGATE, MANCHESTER, and must be accompanied by the name and address of the writer. Anonymous letters will not be noticed. We cannot undertake to return manuscripts or drawings, and correspondents are warned to keep copies.*

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CONTENTS.

EDITORIAL.

WOMEN ENGINEERS.

A Works Staffed with Women.

A new engineering company is being formed, called Atlanta Ltd., with a works in the Midlands, and which, it is stated, will be staffed entirely by women. Lady Parsons is chairman of the company, and the works manager is an educated woman who during the war period was in charge of a machine shop at the British Thomson-Houston Co.'s works. The secretary of the company is also, we are told, a clever woman engineer. It is rather surprising that the directorate includes both sexes.

During the War.

A works run entirely by women is a precedent, but the woman engineer is not new. Women did very good service in engineering workshops during the war, and showed their fitness for many engineering tasks. The unique thing about this new company appears to be that it is being formed on a sex basis. The engineering profession has always in the past been a man's profession, not from design, but because presumably of some process of natural selection. It should not be forgotten that with some notable exceptions the work that has so far been done by women has been of a simple kind and required neither special aptitude nor much training. Tracing drawings is quite suitable work for women, but it does not call for great skill, and the same remark applies to the operating of shell-turning lathes or automatic gear-cutting machines. Whether the average woman can acquire skill as an engineer has yet to be proved. The point is, is it worth while trying to prove it?

An Industrial Question.

We have neither space nor inclination to thrash out the debatable question of whether women are as mathematical as men. The whole matter appears to be purely an industrial and economic question. Is the labour market so overcrowded that women must find new outlets? It would not appear so. There are other industries peculiarly suited to women, such as cardboard boxmaking, which are crying out for workers. The position is entirely different from what it was during the war period, when suitable peace-time work was at a standstill.

Work which is Suitable.

If women mean seriously to enter engineering and be successful, it will not be in competing with men, but in co-operating with them. Differentiation is needed. The question is not on a level with the entry of women into what are called the "learned professions." Exceptional women may train themselves for administrative positions, but while many tasks in the shops can be performed by women, others are quite unsuitable, and this applies to all classes of engineering. If there is any real demand by women to enter engineering, there will be no objections by men; but it would be much wiser to sort out tasks and let women specialise either in trades within the industry which are light, and consequently suitable, or do the lighter work of the heavy trades.

SIR WILLIAM MATHER, P.C., LL.D.

Sir Wm. Mather, who died on the 18th September, will be much missed. He was a great engineer, but his activities were almost boundless. Educated at private schools in England, and afterwards at Dresden, he served an apprenticeship at his father's works in Manchester, and was taken into partnership in 1862, when only 24 years of age, and took over the sole management of the business in 1871.

He was chiefly responsible for the establishing of the manual training school for boys in the Manchester Mechanics' Institute, was keenly inter-

THE LATE SIR WILLIAM MATHER, P.C., LL.D.

ested in the Manchester School of Technology, and the first president of the Association of Technical Institutions.

As an engineer he was always enterprising, and in 1884 acquired the manufacturing rights of the Edison dynamo, and his firm was, if not the first, one of the first to make compound high-lift turbine pumps.

Sir William was an enthusiast for welfare work, and it will be remembered that as far back as 1883 he adopted the eight-hour day, and defended it not as a philanthropic measure, but on business grounds.

REINFORCED CONCRETE ROADS. A plea in favour of reinforced concrete roads is put forward by Mr. A. G. H. Baxter, of Finsbury Park, who asserts that a two-ton lorry, loaded, will travel more than two miles farther per gallon of petrol on a concrete road than on a bituminous macadam road, and that a truck with an overall weight of 8 tons will travel about 33 and a third per cent farther per gallon on a concrete road than on a bitulithic road.

RAILWAYS IN JUGO-SLOVAKIA. — A Russian Financial Syndicate, which is said to dispose of a capital amounting to two thousand million French francs, has lodged an appeal with the Southern Slav Government for a concession to construct a line of railway from Belgrade *via* Sarajevo to Split (Spalato), and also to enlarge the Adriatic harbour. Five years will be required to complete the work. In return the Syndicate requests the right to work this line for several years, to be ultimately determined.

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By ERIC M. BERGSTROM, of London.
Associate Member of the Institution of Mechanical Engineers.

(Continued from page 6, Sept., 8 & 22.)

THE most recent type of thrust-bearing is the "Kingsbury," which now severely contests the place of the roller-bearings, and has been adopted in America in connection with most recent vertical turbine plants. The invention is based on the theory of the wedge-shaped oil film to support the load as put forward by Professor Osborne Reynolds in his standard work on "Theory of Lubrication."*

The construction of such a bearing is seen from Fig. 13, and consists, as in the case of the oil-pressure bearing, of one stationary and one revolving disc, the former, however, composed of several segments, each of which is mounted on a pivot to permit the slight angular displacement relatively to the rotating disc necessary to allow the film of oil to assume the wedge form. The outstanding feature of the Kingsbury bearing is the very low frictional loss as compared

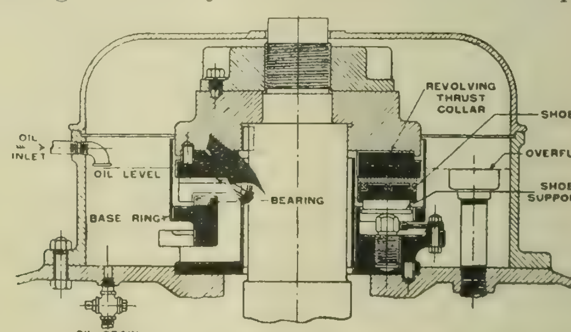


FIG 13.—Kingsbury Thrust Bearing. Designed for 180,000 lb. thrust load at 100 r.p.m. Outside Diam. of Thrust Collar 31 inches.

with any other type of thrust bearing. From tests made with these bearings in connection with a 10,000 H.P. vertical turbine at 100 revolutons per minute, the friction loss amounted to from 7½ to 10 k.w., or approximately one-tenth per cent of the total power, which fact serves to explain the very high values of total efficiency obtained with modern vertical turbine plants. Not only has the hydraulic efficiency been improved upon, but the mechanical efficiency has, by the adoption of efficient bearings, attained a value closely approaching 100 per cent.

It will be observed that when running there is no metallic contact, the load being supported upon a film of oil and consequently permitting a very much higher specific pressure per square inch of bearing surface than could be allowed in roller bearings, and hence, with equal load and speed, the Kingsbury bearing would have smaller dimensions than in the case of any other type of bearing. The load to be supported at the Mississippi plant is, as before stated, 255 tons; the diameter of the bearing is 56 inches, with a specific pressure of 350 lb. per square inch. As will be seen from the sectional drawing, the bearing is placed between the turbine and the generator and is accessible from a platform in the inspection shaft. The shaft has a diameter of 25 inches in the

* Phil. Trans. 1886.

bearing, and is coupled direct to the generator shaft by means of a solid flanged coupling.

The turbines were tested in place, and the efficiency obtained averaged 90 per cent for all units. The generators are of the "umbrella" type with a capacity of 9,000 kva. at 0·8 power factor and rated at 11,000 volts, 3-phase current, 25 cycles, and designed on the principle of a revolving field inside a fixed armature. The extreme outside diameter is 31 feet 5 inches, and the diameter of the revolving field 25 feet 5 inches, the guaranteed efficiency at full load being 96·3 per cent including all losses from friction and windage. The electrical equipment also includes a step-up transformer, increasing the voltage from 11,000 to 110,000 volts for transmission to St. Louis at a distance of 144 miles from the power-house.

From this short description of the Mississippi power plant, one cannot fail to observe that, in spite of the enormous size and capacity of the plant, the arrangement is the acme of compactness and simplicity and does not possess the objectionable features inherent to the previous practice of multiple runners. The advantage of the single-runner type is at once evident, if reference is again made to the sectional drawing, Fig. 12. The outstanding feature is the absence of any submerged bearings, and the thrust-bearing, guide-bearing, regulating-gear, and in fact all auxiliary parts of the runner, are above water level and readily accessible for inspection and necessary repairs.* The cost of maintenance is less, and the arrangement with a single suction-tube secures the highest possible efficiency, together with simpler and cheaper construction of the foundations.

In concluding this brief description of the development of large single-runner Francis turbines for low heads, it may again be emphasised that this development represents the most important advances in hydro-electric practice in recent years, and since its successful inauguration in 1912 it has subsequently been adopted in a number of prominent low-head plants, including the following:—

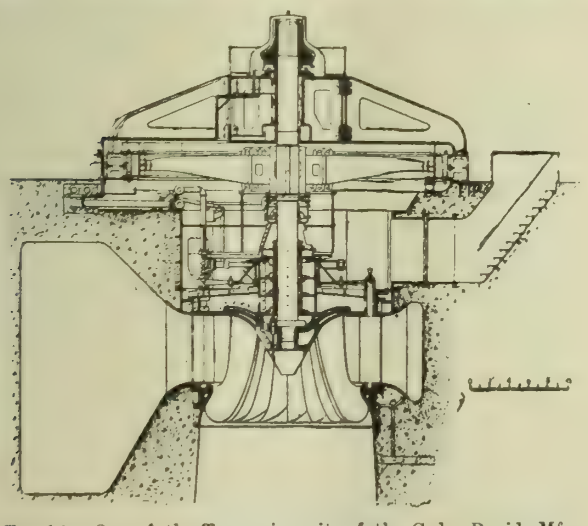


FIG. 14.—One of the Ten main units of the Cedar Rapids Mfg. and Power Co., Canada.

Alabama Power Company, Loch No. 12, Coosa River: 6 units—17,500 B.H.P. each, 100 revolutions per minute, 68 feet head.

Cedar Rapids Manufacturing Company, St. Lawrence River, Canada: 12 units—10,800 B.H.P., 55·6 revolutions per minute, 30 feet head; ultimate installation 18 units.

Laurentide Company Ltd., Grand Mere, Quebec, Canada: 6 units—20,000 B.H.P., 120 revolutions per minute, 76 feet head; ultimate installation 10 units.

The turbines for the Cedar Rapids are the largest ever contemplated, and show a few interesting improvements over the early Mississippi type. The most notable of these improvements is in the design of the foundation-ring, or the so-called "speed-ring," which instead of being cast in two rings, one upper and one lower, and connected by means of stay-bolts, is now cast with vanes connecting the two rings and given fin-shaped section, which offers less hydraulic resistance and from a mechanical point of view is preferable as being a solid connection between two rings, Fig. 14.

Another point which is worth mentioning, and also seen from the sectional drawing referred to, is the practice of arranging the combined thrust-bearing on the top of the generator instead of below floor level, the advantage being greater accessibility. The Kingsbury bearing has been employed throughout this plant, but a novel feature has been introduced, the bearing being combined with a roller-bearing of reduced dimensions. Normally the roller-bearing is not in action, being set with a slight clearance, but in case of weeping action of the Kingsbury bearing taking place, it would support the load for a time, and prevent any serious breakdown of the plant.

In the adoption of large vertical turbine units has been found the solution of many undeveloped low-fall hydro-electric schemes, and even larger units than hitherto made have been contemplated, and it is safe to predict that the undoubted economic features of this type of installation will lead to great future progress in the utilisation of water-power under low head. Although the vertical arrangement has not been adopted in Europe for such large developments as those described of American construction and operating under heads of from 30 to 70 feet, it has been used extensively for water-power developments under extremely low heads up to about 10 feet or where large fluctuations both in height of fall and quantity of water render this construction necessary, the usual method being to employ two or more runners on the same shaft, of which only one or two are operating under low-fall periods.

The Chester Municipal Hydro-Electric Power Station is a typical extreme low-fall development operating under an average head of 7 feet, although during certain periods of the year the head falls as low as 5 feet and sometimes reaches a maximum of 9 feet. A section and end elevation of the power-house is shown in Figs. 15 and 16, the plant comprising two units designed for a quantity of water of 30,000 cubic feet per minute, and one smaller unit to deal with 22,000 cubic feet per minute, all under a maximum head of 9 feet, corresponding to an output of 415 H.P. for the larger and 305 H.P. for the small unit, the speed being 50 and 55 revolutions per minute respectively.

Each turbine is set in a rectangular concrete pit, with concrete-lined suction-tube. The cast-iron regulating ring on the turbine is connected to each

* H. Birchard Taylor, "Vertical Shaft Single-runner Turbines as Applied to Low Heads."—*General Electric Review*, June, 1913.

guide-vane by means of pins and levers and is operated by hand from the power-house floor, and the submerged guide-bearing on the top of the casing is lined with babbit metal and grease-lubricated through pipes from floor level. The vertical shaft equipped wih automatic governors, but are operated entirely by hand and work with full gate opening as far as permissible, while the speed varies according to the fall available. This arrangement secures the maximum output under the prevailing conditions.

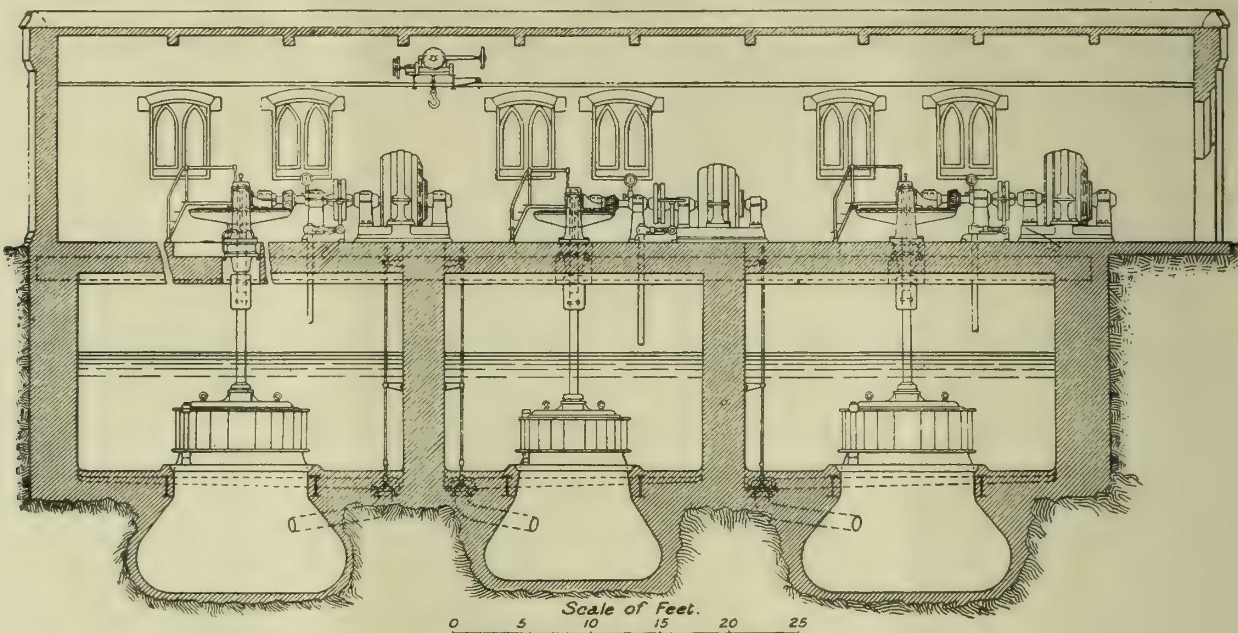


FIG. 15.—Chester Hydro-Electric Plant.

is supported by a collar thrust-bearing running in oil bath and combined with guide-bearing to take the side thrust from the helical bevel-wheels, which transmit the power through a flexible coupling to the d.c. generators arranged with horizontal shaft.

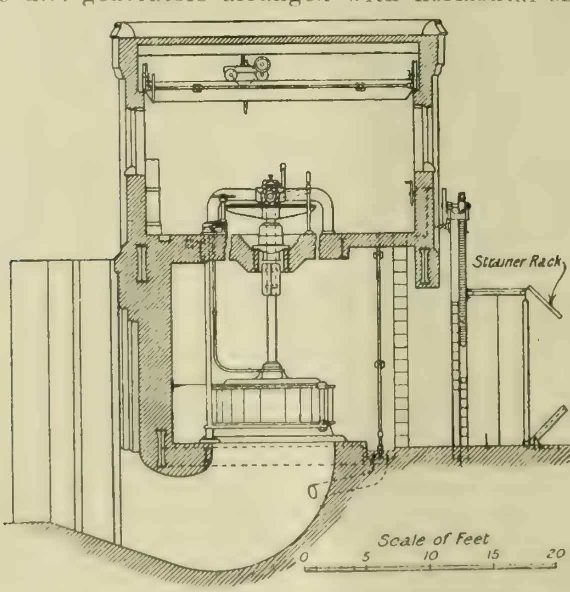


FIG. 16. End Elevation of Large Turbine. Chester Hydro-Electric Plant.

The position of the power-house is such that it is affected by tidal water, hence a frequent variation of fall which had to be taken into consideration when designing the turbine plant; and as the load can be kept practically constant, the turbines are not

(b) Horizontal Low-pressure Turbine Plants.

The Hydro-Electric Power Station at Forshulten, Sweden, represents a typical plant of this arrangement, of which a section is shown in Fig. 17. The units, of which there are six in operation, are arranged with double runners on horizontal shaft with an output of 3,000 H.P., each running at 187

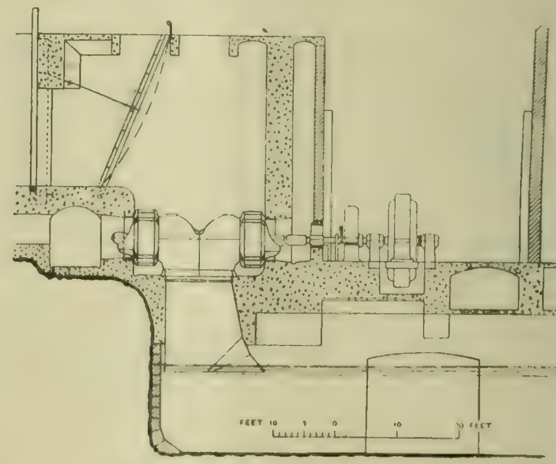


FIG. 17.—Hydro-Electric Power Station at Forshulten, Sweden.

revolutions per minute under a net fall of 42·6 feet and placed in open concrete pits protected by sluice and strainer-racks, the two runners discharging into a common cast-iron suction casing designed with easy curves diverting the water to the suction tube. The shaft is supported at each runner on two outside ring lubricated bearings, in addition to a babbit-lined

automatically grease-lubricated bearing inside the suction-casing. The practice of providing horizontal turbines with lignum vitæ under-water bearings has now been discontinued in favour of outside ring oil-lubricated bearings, the bearing on the inlet side being made accessible through an inspection tunnel as in the present case or through a vertical steel funnel protruding above high-water mark.

More than usual interest is presented by the arrangement adopted at Mockfjaerden Hydro-Electric Power Station, Sweden, on account of the power-house being situated underground and using open turbines under the relativelyhigh fall of 72 feet. The arrangement of the plant is seen from Fig. 18, and comprises for units each having an output of 5,000 B.H.P. at 225 revolutions per minute with

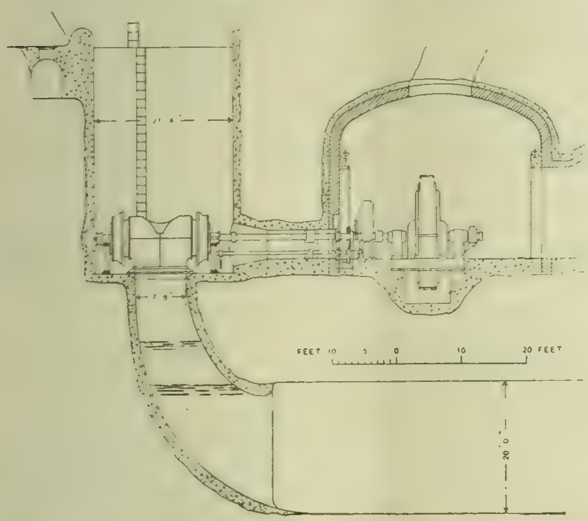


Fig. 18.—Mockfjaerden Hydro-Electric Power Station, Sweden.

double runners on horizontal shafts. Each turbine is placed at the bottom of a concrete-lined shaft and discharges into the common tail-race tunnel. The power-house is blasted out of solid rock, the floor level being approximately 70 feet below the surface, whereas the switchboard and transformers are housed in a separate building on ground level and communicate with the power-house below through an inclined shaft. The alternators are directly connected to the turbine-shaft and, due to the underground situation, special arrangements had to be made to ensure sufficient cooling. For this purpose the alternators are totally enclosed and cold air is forced down a separate shaft and distributed through underground ducts to each alternator, the hot air escaping from the top of the housing and expelled through the vertical shaft communicating with the surface.

The foregoing turbine plants will suffice to illustrate the various modes of arrangement of open low-pressure turbines, and no doubt has conveyed that no hard-and-fast rule can be laid down as to the adoption of any particular type, this being entirely dependent on the nature of the available head, the topographical and other local conditions. It is the study of these conditions for each individual case and the adoption of the type of turbine best suited to fulfil these requirements which has influenced the modern development of water-power installations and contributed to the economical utilisation of low falls.

(To be continued.)

COAL-OIL MIXTURES.

By Harold Moore,
M.Sc.Tech., A.M.Inst.Pet.Tech.

The use of liquid, as an alternative to solid fuel, offers many advantages, and were there sufficient supplies of liquid fuel available, at prices approximating to that of coal, the general application of oil-firing in industry would undoubtedly take place.

The advantages of oil over coal may be divided into two categories. In the first come the advantages derived from the better heating power and greater homogenity of the fuel, and in the second certain advantages entirely due to the physical state of the fuel, as being liquid instead of solid. To explain more clearly, the heat value of petroleum per unit of weight is much greater than that of coal; roughly, 50 per cent greater; also petroleum seldom contains more than 0·1 per cent of ash, whereas the ash content of coal frequently exceeds 10 per cent. These advantages are due to the chemical nature of the fuel, and would still apply even if the petroleum could be frozen into the solid state. On the other hand, the advantages caused by the convenience in conveying liquids by pumping, and the more effective control of combustion when the fuel is capable of being sprayed into the furnace, are entirely due to the fuel being in a liquid state, and would still apply, even were the fuel low in heat value and high in ash content. Any method of converting a solid fuel into a liquid fuel is a distinct saving, provided that the cost of conversion and the loss during conversion are small.

At the time of writing, furnace oil (petroleum residuum) is being marketed at a price of £10 7s. 6d. per ton in this country, whilst coal prices are about £2 per ton. In spite of this enormous difference in cost considerable quantities of liquid fuel are being burned, this being mainly due to an absolute shortage of coal and to the exceedingly low quality of the coal being received by some users. There does not appear to be much hope of an immediate improvement in the quantity and quality of coal available in this country, whereas there is considerable hope of reduction in oil tank ship freights from the other side of the Atlantic, and the cost of freight forms by far the larger portion of the cost of the oil in this country at the present time. We may therefore conclude that oil will remain in use for boiler firing in this country, at least for the immediate future.

By reducing coal to an exceedingly fine state of division it is possible to cause the dust to remain in suspension in oil for prolonged periods. The time taken for a certain percentage of the coal to settle from a state of suspension is mainly dependent upon the size of the coal particles, and to a lesser degree upon the respective densities of coal and oil, and also upon the viscosity of the oil.

The cost of pulverising the coal to such a degree of fineness as allows the mixture to be stored, transported, etc., without any serious portion of the solid fuel separating, is too high to warrant the use of simple coal-oil mixtures. It has, however, been found that by the addition of small quantities of other substances the coal may be kept in suspension for months, even if the coal be only pulverised to a degree of fineness commercially practicable.

The substances, usually called "fixateurs," used for this purpose are at present the secret of the several inventors of these processes, and it is claimed that a satisfactory stable suspension need only contain about 1 per cent of fixateur, if the coal be pulverised to such a state of fineness that 95 per cent will pass through a screen of 100 meshes to the inch and 85 per cent through one of 200 meshes.

Mixtures containing 40 per cent of coal with 60 per cent of average grade fuel oil are liquids, while mixtures containing between 40 per cent and 75 per cent of coal may be classified as pastes of various consistencies. Because of the coal content, the specific gravity of the mixed fuel is much higher than that of petroleum, and though the heat value of the mixture is lower than that of petroleum per unit weight it is usually higher per unit volume. As a result of this the fuel does not occupy any greater storage space than oil—an important point in marine practice.

The actual cost of preparing such coal-oil mixtures, usually alluded to as "colloidal fuel," is stated to be about 7s. per ton, apart from the cost of the ingredients, therefore there is a considerable saving affected by the mixing of coal and fuel oil in any case in which the difference of price in the two commodities is more than about £1 for the heat value equivalent of one ton of oil. The saving should be very considerable where the prices are so widely divergent as they are in this country, that is, about £2 per ton for coal and over £10 per ton for oil. Some of the cheaper varieties of small coal may be used for this purpose.

The colloidal fuel may be passed through preheaters before reaching the burners in order to reduce its viscosity and assist combustion. Though the stability of the suspension is much reduced at high temperatures, no trouble is experienced by the settling out of solid in the short period during which the oil is in the pre-heater.

The wearing action of the solid particles on the burner mechanism is very slight, and does not cause trouble. The combustion is as easy to control and as efficacious as with oil, as has been demonstrated in numerous boiler trials.

The principal advantages to be gained by the use of this system of firing are:—

1. The use of a fuel which is cheaper than oil, even when heat value has been taken into account. This procedure tends to economise our oil resources.

2. The attainment of high boiler efficiencies as a result of good control of the conditions of combustion.

3. Rapid steam raising, and the minimisation of stand-by losses.

4. Greater output from the boilers than when using solid fuel.

5. Less trouble with ash removal, most of the ash being passed up the chimney.

For marine purposes there are several special advantages, such as ease and rapidity of bunkering by pipe line, and the comparative cleanliness of the bunkering process, the small space occupied by the fuel, and the possibility of using ships' double bottoms as storage space, thus leaving other space free for cargo carrying.

In the opinion of the writer coal oil mixtures are not suitable for use in internal-combustion engines. Even the slow speed, two-cycle, large size Diesel engines, which are particularly suited for burning low grade fuels, would not cope satisfactorily with oils containing any appreciable quantity of coal. The reason for the inability of oil engines to deal with this type of fuel is the extreme sensibility of all reciprocating internal-combustion engines to the ash content of the fuel. It is usual to specify an ash content of not more than 0·05 per cent in oils required for Diesel engines, and though oils of higher ash content are occasionally consumed, there is no likelihood of incorporating any appreciable quantity of coal or other solid fuels in the oil without raising the ash content to values considerably in excess of the amount permissible in Diesel engines.

The extreme sensitiveness of engines to ash is easily understood when it is borne in mind that a proportion of ash becomes mixed with lubricating oil on the cylinder walls, and this accumulates. The accumulated ash content of oil burned during several days amounts to a large quantity, even though the percentage of ash content of the oil be very small.

Coal-oil mixtures should be particularly safe to handle, as they are always higher in specific gravity than water, and can therefore be stored under a water seal, and in case of fire it is possible to flood water over the oil, a procedure which is impossible when dealing with ordinary petroleum oil.

The oil used for mixing this class of fuel is usually a petroleum residue, or other petroleum product, but in case of need coal tars or coal tar distillates may be used.

Though it is too early to prophesy as to the future of these mixed fuels, there appears to be a considerable possibility of their being largely used in the industries, and particularly for marine purposes, in the early future.—*Manchester Guardian.*

Messrs. T. H. Watson & Co., Neepsend, Sheffield, have sent us their catalogue of furnaces printed in Russian. It is well illustrated, and the firm will be pleased to supply any information to enquirers.

Thornycroft Motors.—We have received from Messrs. Thornycroft & Co. Ltd., a photograph showing a large number of 40 H.P. "J" type chassis which recently arrived in India for the Gwalior Motor Service Co. of Delhi. The chassis were sent in sections from the Basingstoke works and reassembled at the works of the subsiding company, Thornycroft (India) Ltd. They will be used chiefly for transporting the clerical staff between the Government offices and residential quarters. India has alread abysorbed a large number of Thornycroft ex- service vehicles for passenger and goods transport, in addition to the very large number of Thornycroft 2-tonners which were used by the Indian Army during the war, and retained in the Colony for commercial use.

Destructive Soot and Smoke.—It will be news to many people that at least 50 per cent of the admitted smoke nuisance in Great Britain is attributable to domestic chimneys, up which something like 2,500,000 tons of soot escapes in these islands. This represents about 6 per cent of the domestic consumption of 40,000,000 tons of bituminous coals. About one per cent of sulphur in such coals escapes as sulphuric acid, which acts as a corrosive on building stones. Striking evidence and photographs of damage done in this way to the Houses of Parliament, Buckingham Palace, Somerset House, etc., were placed before the Committee on Smoke and Noxious Vapours Abatement, and Sir Frank Baines stated that one-half of the necessary repairs and upkeep to public monuments and buildings could be saved if a pure and smoke-free atmosphere could be obtained. Up to the present, legislation affecting the emission of black smoke has covered only factories, locomotives and industrial works generally, but in their final report the Committee referred to will discuss the advisability of domestic smoke coming under legislative restrictions.

INTERESTING EXHIBITS AT OLYMPIA.

Apart from the big machines exhibited at the recent Machine Tool Exhibition at Olympia, there were innumerable smaller exhibits which were valuable from the production point of view. Many of the exhibits were as interesting to the power user as to the engineer. Consider the electric drive, for instance, although it may not be quite correct to speak of the many features under the head as smaller exhibits. Apart altogether from its universal adoption in the exhibition itself, there were exhibits showing the efficacy of the electric drive, which demonstrated the wonderful advance made in recent years.

Power Transmission.

The exhibition gave plenty of scope for the study of the whole problem of power transmission, because, apart from the direct drive, all types of belts were to be seen in actual operation, and many of the best known materials for the treatment of belts.

It is impossible to itemise the many interesting small tool exhibits, even apart from those for power transmission. The very latest precision measuring instruments were to be seen, and there were many novelties.

Motor Control Panels.

The British Thomson-Houston Co. exhibited their various types of motor control panels, which combine in a convenient form the apparatus required for starting and controlling direct current motors (Fig. 1).

Fig. 1.

Fig. 2.

The equipment of these panels consists of a sheet steel base carrying a starting rheostat and a switch fuse, the whole apparatus being designed to comply with the Home Office rules for the use of electricity in factories. There are no exposed live parts, and neither the starter nor the switch fuse can be left in partial contact, which eliminates the chance of fire.

The switch pole is of the double-pole quick-break type enclosed in an iron case. The fixed contacts are mounted in percelain bases, and the movable parts are attached to the hinged cover.

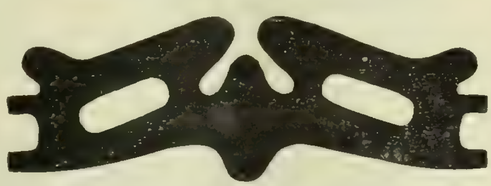
The starting rheostat consists of a switch and resistance totally enclosed in a cast-iron case having a glazed opening for the inspection of the switch and contacts, and it may be stated that these panels can be fitted with one or two instruments, in addition to the switch fuse and starter.

A "Nibbling" Machine.

A machine which deservedly attracted considerable attention was the nibbling machine, called Wilson's patent nibbling machine, and which is made by Messrs. J. B. Stone and Co. Ltd., Finsbury Pavement, London, E.C.

It has been designed to facilitate the cutting and shaping of sheet metal to design or pattern when the quantity required is insufficient to justify the making of press tools.

Nibbling Work—Old way, 2½ hours.



Nibbling Work by machine—10 minutes.

Fig. 3.

The machine is simple in construction, and may readily be operated by unskilled labour. Removable cutting tools are, of course, arranged, these being inexpensive and easily inserted or removed. They are formed from round tool steel, shaped on the cutting edge to effect a grip on the sheet metal and to ensure that each cut is effectively made. The circular section of the cutter allows of traverse to allow any shape or direction to suit the needs of the work.

Fig. 2 illustrates the smallest machine made, a size largely employed in the production of aircraft fittings during the war, whilst Fig. 3 clearly illustrates the difference between work produced by a punch and nibbler respectively. The makers claim

that the work can be so finished as to require no filing after leaving the machine.

It is not necessary to do more than describe the machine—its value in every shop which has a lot of sheet-metal work, and this applies to most places. In a repair shop, especially for the

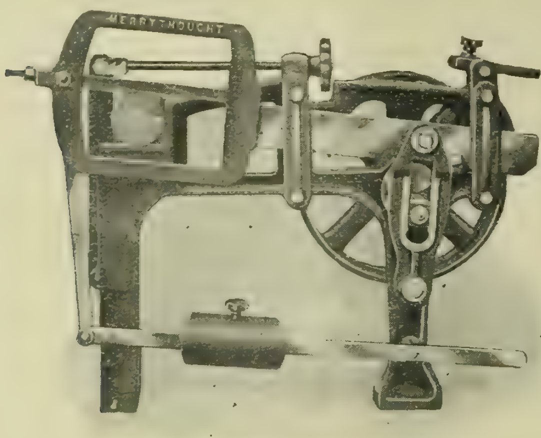


FIG. 4.

multifarious "odds and ends" jobs that have to be done, such a machine ought to be well employed.

A Novel Hacksaw.

There were many saws to be seen at the exhibition, but the one illustrated by Fig. 4 is another machine minimum, and it is claimed for it that any wear that does take place is not magnified or exaggerated may turn over at the blade, as is frequently the case. The bearing surfaces, which ensure trueness of cut, are of ample dimensions, and therefore not much subject to wear, which should certainly prolong the life of the machine.

Quick-action Vices.

Several firms exhibited vices, one of the best known being Messrs. W. Carr & Co., Queen Victoria Street, London, E.C.4. One of their vices is shown at Fig. 5. These vices are as the name implied, made from semi-steel, with saddle and base in one piece, which ensures great strength and rigidity. The grip is positive because of the automatic locking of the screw with a bronze nut. It is claimed by the firm that the action is exceptionally quick and efficient because there is no trigger or spring or indeed any other small parts to get broken. The firm also manufacture a vice on a swivel base which is a very handy type.

"Hoffman" Ball Bearing.

There were many excellent ball and roller bearings on view at the exhibition, and the importance of these is growing daily with the continual rise of power costs. The "Hoffman" is a typical and outstanding design of ball bearing, and a countershaft with the bearing is illustrated by Fig. 6.

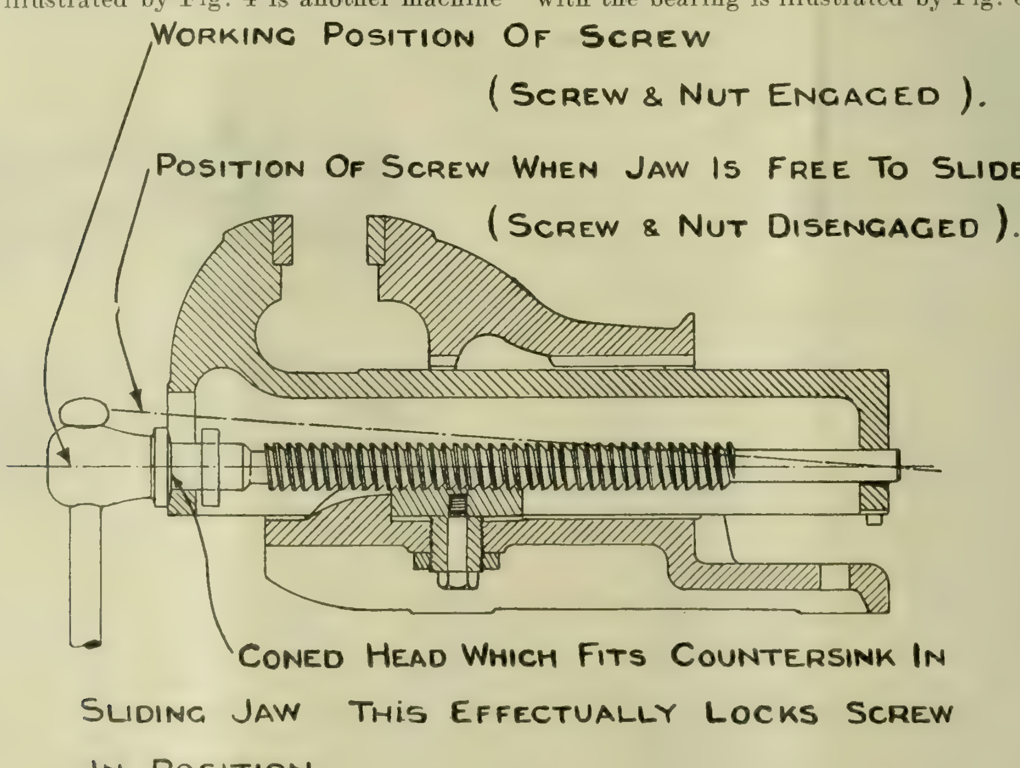


FIG. 5.

specially useful for small work and the repair shop, for which it was really designed.

The "Merrythought" hacksaw, which is made by Messrs. C. Wicksteed & Co. Ltd., Kettering, is of simple design. The number of wearing parts that affect the trueness of the cut have been reduced to a

It is for use in connection with very light machine tools.

As will be seen from the illustration, it is extremely simple to erect. Should it be necessary to fix this countershaft in a specially awkward position, by removing two bolts above and below the main

housing, the spindle, pulleys, etc., are easily detached, thus leaving only the light bracket to be held in position.

The main spindle is mounted on two ball bearings, and the loose pulley on another, this giving the highest efficiency and freedom from frictional losses. Ample means are taken to protect the bearing from the ingress of dirt and moisture, these being similar to those adopted for the hangers, A special feature of the belt shifting gear is that it is automatically locked in both positions.

There is no more fruitful source of trouble in the average machine shop than the countershaft bearings. They are wasteful of power and lubricant and require constant attention. A breakdown of these bearings will frequently put an expensive machine out of commission for hours.

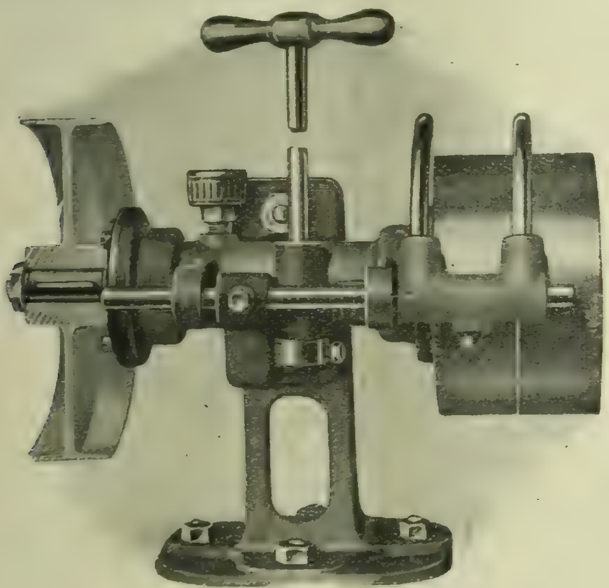


Fig. 6.

Where plain bearings are used on the countershaft it is almost impossible to keep the shaft in alignment. The stroke is adjustable to the width of the belt, and end. This greatly increases the wear and tear on the belts, particularly if flanged pulleys are used. The high speeds common in modern practice call for something better.

There is the usual striking gear on the crank principle; positive and without any risk of shifting. The stroke is adjustable to the wdth of the belt, and the position of the striking gear is variable to suit the diameter of the pulleys. The belt forks can be moved to any position along the bar or reversed to suit the run of the belt.

A Belt Lacer.

It is quite essential for the belt lace to be of great value that it be simple, and this is the claim, the justifiable claim we think, of Messrs. R. Lloyd and Co., Steelhouse Lane, Birmingham, for their "Peerless" belt lacers (Fig. 7).

The rolls and gears are made of the best steel, and hardened, and all parts are interchangeable and can be replaced without the necessity of sending the machine back to the makers, or to a machine shop.

The machine consists of three corrugated rolls operated by a crank; a spiral needle is inserted between the rolls, and by revolving the crank it is carried through the ends of the belt, making small perforations therein, into which the coiled wire lacing is afterwards inserted in the same way as the needle. The coils are then flattened and forced well into the belt and the ends coupled together by means of raw hide pins, twine or other suitable material. It only requires two sizes of coil lacing, and indicates automatically the size required. Both ends of a belt (not exceeding in width the capacity of the machine) can be laced at the same time.

Fig. 7.

The joint forms a hinge which passes over pulleys noiselessly and without slippage, and these ought to reduce the vibration and wear in the boxes and shafting; a big advantage of such a joint over an endless glued belt is, of course, that it can be connected or disconnected very quickly.

Belts.

Quite a bulky volume could be written on the belts that were used and on exhibition. For instance, there were the "Geje" buffalo belting (Fig. 8) of Messrs. Irwin and Jones, New London Street, London. This belt is expensive, but the makers claim that on account of its long life it is ultimately cheap. It is composed of a number of chrome tanned strips of leather running on edge. The leather strips are cut from selected buffalo hides which are tanned by an improved chrome process, which maintains the great strength of the material and yet produces a leather which is exceedingly flexible. These strips, which vary in depth from $\frac{5}{16}$ in. to nearly $\frac{3}{4}$ in., are fastened

together in parallel rows, at a certain distance from each other, by means of steel rivets or rods.

The rivets or rods, being fixed in a "staggered" or cross alternate manner, give the belts a very great transversal suppleness, which ensures that the *whole width* of the belt is doing work.

The makers state greater adherence is obtained with the belt than with ordinary double leather belts:—

(*a*) By the mode of operation of the leather acting on edge.

(*b*) By the fact that the belts do not simply pull on the middle or curved part of the pulleys, but over the whole width of the pulley; that is, that every strip is in intimate contact with the pulley.

belt can be shortened very quickly and without difficulty by unskilled workmen.

Belt Treatment.

From belt to belt treatment the transition is easy. The treatment of belts is one of the most important problems with which the power user has to contend. All sorts of proprietary articles are on the market, many of them no doubt quite satisfactory. Most of these preparations are really belt dressings, but the belts which are shown running slack in Figs. 9 and 10 have been treated not with a dressing, but with what is called cling-surface, which is manufactured by Messrs. Thomas & Bishop, Tabernacle Street, London, E.C. It is really an artificial means of

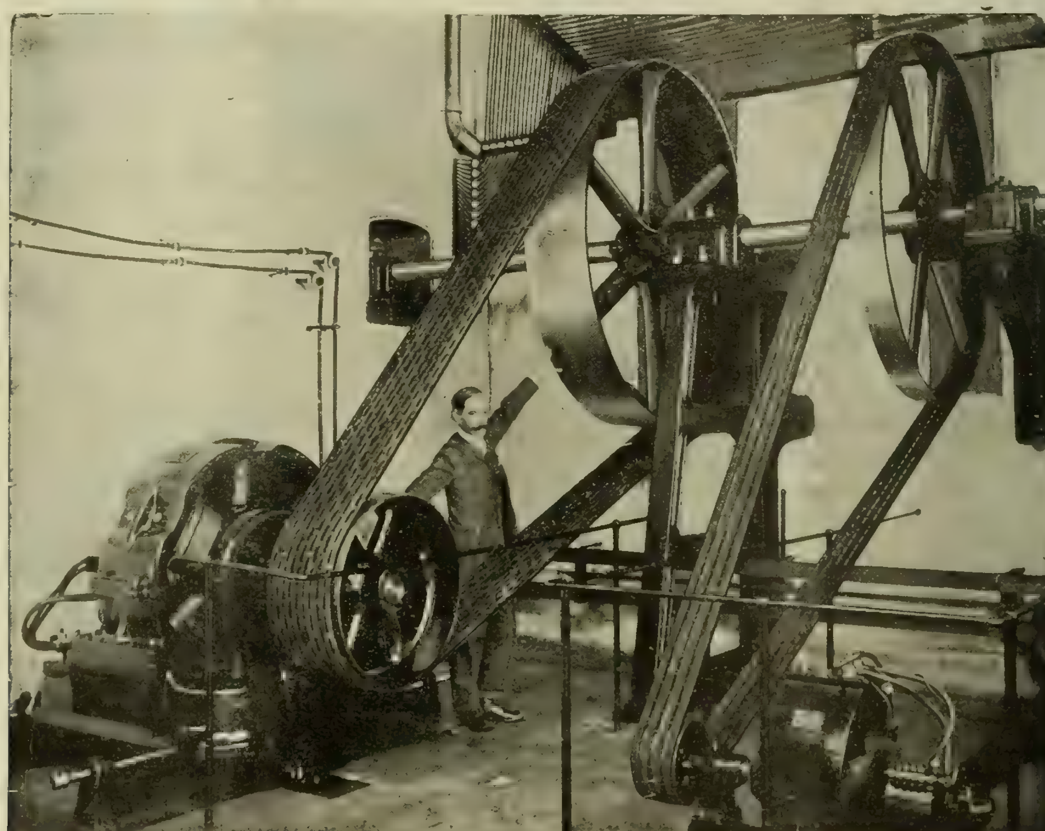


FIG. 8.

(*c*) By the fact that there cannot be any air left, or pocketed, between the belt and the pulley.

Atmospheric changes do not affect these belts, which run satisfactorily in damp places (even with water dripping on the belts). In paper mills, breweries, dye houses and other places where there is a great deal of moisture and vapour in the air, the "Geji" belt gives excellent results. It will also run well in hot places.

These belts can be supplied spliced as an endless belt, and this form is mostly used where the centres of the shafts can be varied, as in dynamo driving or a motor driving on to a machine or line shaft, and where the motor or dynamo is provided with a sliding base.

For ordinary machine use the makers supply belt fasteners of various forms, all of which are satisfactory in operation and easy to fix. By their use the

securing the qualities of flexibility and grip which are absolutely indispensable to ensure economical power transmission. Interesting models were on view at the exhibition showing the effect of this article on belts, showing how it increases the flexibility and prevents slippage. The illustrations show belts running slack and yet transmitting power.

The application of cling-surface to belts is a simple operation. 100 ft. of 6-in. leather oak-tanned belt will absorb about 4 lbs. of cling-surface to complete the initial stuffing. This is done gradually, a very little at a time, and as fast as one dose is absorbed into the belt another application is made. The initial stuffing is practically permanent, and when completed that 100 ft. of belting can be maintained in perfect working condition by the further use of less than ¼ lb. of cling-surface per year, or, in other words, a small application once every six weeks. The firm

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 95 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 1 26	0 16 3 24	1 5 1 22	1 13 3 20	2 2 1 18	2 10 3 16	2 19 1 14	3 7 3 12	3 16 1 10	0
1	0 3 11	9 1 9	0 17 3 7	1 6 1 5	1 14 3 3	2 3 1 1	2 11 2 27	3 0 0 25	3 8 2 23	3 17 0 21	1
2	1 2 22	10 0 20	0 18 2 18	1 7 0 16	1 15 2 14	2 4 0 12	2 12 2 10	3 1 0 8	3 9 2 6	3 18 0 4	2
3	2 2 5	11 0 3	0 19 2 1	1 7 3 27	1 16 1 25	2 4 3 23	2 13 1 21	3 1 3 19	3 10 1 17	3 18 3 15	3
4	3 1 16	11 3 14	1 0 1 12	1 8 3 10	1 17 1 8	2 5 3 6	2 14 1 4	3 2 3 2	3 11 1 0	3 19 2 26	4
5	4 0 27	12 2 25	1 1 0 23	1 9 2 21	1 18 0 19	2 6 2 17	2 15 0 15	3 3 2 13	3 12 0 11	4 0 2 9	5
6	5 0 10	13 2 8	1 2 0 6	1 10 2 4	1 19 0 2	2 7 2 0	2 15 3 26	3 4 1 24	3 12 3 22	4 1 1 20	6
7	5 3 21	14 1 19	1 2 3 17	1 11 1 15	1 19 3 13	2 8 1 11	2 16 3 9	3 5 1 7	3 13 3 5	4 2 1 3	7
8	6 3 4	15 1 2	1 3 3 0	1 12 0 26	2 0 2 24	2 9 0 22	2 17 2 20	3 6 0 18	3 14 2 16	4 3 0 14	8
9	7 2 15	16 0 13	1 4 2 11	1 13 0 9	2 1 2 7	2 10 0 5	2 18 2 3	3 7 0 1	3 15 1 27	4 3 3 25	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs	Weight.
	7·92	15·84	23·76	1 3·68	1 11·6	1 19·52	1 27·44	2 7·56	2 15·28	2 23·2	3 3·12	3 11	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 95 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	4 4 3 8	8 9 2 16	12 14 1 24	16 19 1 4	21 4 0 12	25 8 3 20	29 13 3 0	33 18 2 8	38 3 1 16	0
10	0 8 1 26	4 13 1 6	8 18 0 14	13 2 3 22	17 7 3 2	21 12 2 10	25 17 1 18	30 2 0 26	34 7 0 6	38 11 3 14	10
20	0 16 3 24	5 1 3 4	9 6 2 12	13 11 1 20	17 16 1 0	22 1 0 8	26 5 3 16	30 10 2 24	34 15 2 4	39 0 1 12	20
30	1 5 1 22	5 10 1 2	9 15 0 10	13 19 3 18	18 4 2 26	22 9 2 6	26 14 1 14	30 19 0 22	35 4 0 2	39 8 3 10	30
40	1 13 3 20	5 18 3 0	10 3 2 8	14 8 1 16	18 13 0 24	22 18 0 4	27 2 3 12	31 7 2 20	35 12 2 0	39 17 1 8	40
50	2 2 1 18	6 7 0 26	10 12 0 6	14 16 3 14	19 1 2 22	23 6 2 2	27 11 1 10	31 16 0 18	36 0 3 26	40 5 3 6	50
60	2 10 3 16	6 15 2 24	11 0 2 4	15 5 1 12	19 10 0 20	23 15 0 0	27 19 3 8	32 4 2 16	36 9 1 24	40 14 1 4	60
70	2 19 1 14	7 4 0 22	11 9 0 2	15 13 3 10	19 18 2 18	24 3 1 26	28 8 1 6	32 13 0 14	36 17 3 22	41 2 3 2	70
80	3 7 3 12	7 12 2 20	11 17 2 0	16 2 1 8	20 7 0 16	24 11 3 24	28 16 3 4	33 1 2 12	37 6 1 20	41 11 1 0	80
90	3 16 1 10	8 1 0 18	12 5 3 26	16 10 3 6	20 15 2 14	25 0 1 22	29 5 1 2	33 10 0 10	37 14 3 18	41 19 2 26	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	42 8 0 24	84 16 1 20	127 4 2 16	169 12 3 12	212 1 0 8	254 9 1 4	296 17 2 0	339 5 2 24	381 13 3 20	424 2 0 16	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 97 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 2 18	0 17 1 8	1 5 3 26	1 14 2 16	2 3 1 6	2 11 3 24	3 0 2 14	3 9 1 4	3 17 3 22	0
1	0 3 13	9 2 3	0 18 0 21	1 6 3 11	1 15 2 1	2 4 0 19	2 12 3 9	3 1 1 27	3 10 0 17	3 18 3 7	1
2	1 2 26	10 1 16	0 19 0 6	1 7 2 24	1 16 1 14	2 5 0 4	2 13 2 22	3 2 1 12	3 11 0 2	3 19 2 20	2
3	2 2 11	11 1 1	0 19 3 19	1 8 2 9	1 17 0 27	2 5 3 17	2 14 2 7	3 3 0 25	3 11 3 15	4 0 2 5	3
4	3 1 24	12 0 14	1 0 3 4	1 9 1 22	1 18 0 12	2 6 3 2	2 15 1 20	3 4 0 10	3 12 3 0	4 1 1 18	4
5	4 1 9	12 3 27	1 1 2 17	1 10 1 7	1 18 3 25	2 7 2 15	2 16 1 5	3 4 3 23	3 13 2 13	4 2 1 3	5
6	5 0 22	13 3 12	1 2 2 2	1 11 0 20	1 19 3 10	2 8 2 0	2 17 0 18	3 5 3 8	3 14 1 26	4 3 0 16	6
7	6 0 7	14 2 25	1 3 1 15	1 12 0 5	2 0 2 23	2 9 1 13	2 18 0 3	3 6 2 21	3 15 1 11	4 4 0 1	7
8	6 3 20	15 2 10	1 4 1 0	1 12 3 18	2 1 2 8	2 10 0 26	2 18 3 16	3 7 2 6	3 16 0 24	4 4 3 14	8
9	7 3 5	16 1 23	1 5 0 13	1 13 3 3	2 2 1 21	2 11 0 11	2 19 3 1	3 8 1 19	3 17 0 9	4 5 2 27	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·09	16·18	24·26	1 4·34	1 12·42	1 20·5	2 0·58	2 8·66	2 16·74	2 24·82	3 4·9	3 13	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 97 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	Ft
0	..	4 6 2 12	8 13 0 24	12 19 3 8	17 6 1 20	21 13 0 4	25 19 2 16	30 6 1 0	31 12 3 12	38 19 1 24	0
10	0 8 2 18	4 15 1 2	9 1 3 14	13 8 1 26	17 15 0 10	22 1 2 22	26 8 1 6	30 14 3 18	35 1 2 2	39 8 0 14	10
20	0 17 1 8	5 3 3 20	9 10 2 4	13 17 0 16	18 3 3 0	22 10 1 12	26 16 3 24	31 3 2 8	35 10 0 20	39 16 3 4	20
30	1 5 3 26	5 12 2 10	9 19 0 22	14 5 3 6	18 12 1 18	22 19 0 2	27 5 2 14	31 12 0 26	35 18 3 10	40 5 1 22	30
40	1 14 2 16	6 1 1 0	10 7 3 12	14 14 1 24	19 1 0 8	23 7 2 20	27 14 1 4	32 0 3 16	36 7 2 0	40 14 0 12	40
50	2 3 1 6	6 9 3 18	10 16 2 2	15 3 0 14	19 9 2 26	23 16 1 10	28 2 3 22	32 9 2 6	36 16 0 18	41 2 3 2	50
60	2 11 3 24	6 18 2 8	11 5 0 20	15 11 3 4	19 18 1 16	24 5 0 0	28 11 2 12	32 18 0 24	37 4 3 8	41 11 1 20	60
70	3 0 2 14	7 7 0 26	11 13 3 10	16 0 1 22	20 7 0 6	24 13 2 18	29 0 1 2	33 6 3 14	37 13 1 26	42 0 0 10	70
80	3 9 1 4	7 15 3 16	12 2 2 0	16 9 0 12	20 15 2 24	25 2 1 8	29 8 3 20	33 15 2 4	38 2 0 16	42 8 3 0	80
90	3 17 3 22	8 4 2 6	12 11 0 18	16 17 3 2	21 4 1 14	25 10 3 26	29 17 2 10	34 4 0 22	38 10 3 6	42 17 1 18	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	Weight.
	43 6 0 8	86 12 0 16	129 18 0 24	173 4 1 4	216 10 1 12	259 16 1 20	303 2 2 0	346 8 2 8	389 14 2 16	433 0 2 24	

Compiled and Arranged by T. E. Woodhouse

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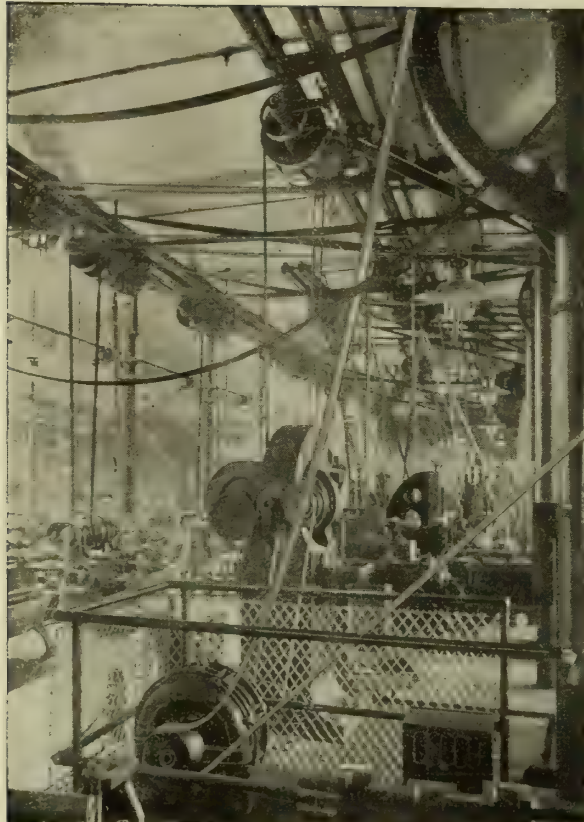


FIG 9.

instance cases where belts, in auxiliary electric plants occasionally used, after the initial treatment has been completed, have run in perfect condition for two years without any further application.

A very important attribute is claimed for this preparation, which is that it does not dry, harden, evaporate, or waste, but accumulates inside the belt or rope, so that when a belt is once stuffed the cost could be put down at a penny or twopence a year for upkeep of an average drive.

BOILER REPAIRING BY ELECTRIC WELDING.*

By A. K. Dawson.

A Lancashire Boiler.

Having recently witnessed repairs to a corroded colliery Lancashire boiler by the use of a portable electric arc welding apparatus, it is the author's intention to describe the method of using this plant and the work done by it.

The boiler in question was one of a group supplying steam at 100 lb. per square inch to Curtis turbo-alternators and other engines. It was 30 ft. long by 7 ft. 6 in. diameter and hand fired. External corrosion had so seriously damaged the shell underneath, between the sludge pipe mounting and the front end plate, that the shell was holed through at one point alongside the angle-iron ring, the latter also being seriously wasted away. To remedy this evil, much time and expense would have been incurred in cutting out part of the corroded shell round about the blow-off hole away from the front end plate, with a view to repair by means of a new cover plate. To secure the latter at a moment's notice would have been by no means easy at the present-day

* From a paper read before the Associates' and Students' Section of the North of England Institute of Mining and Mechanical Engineers.

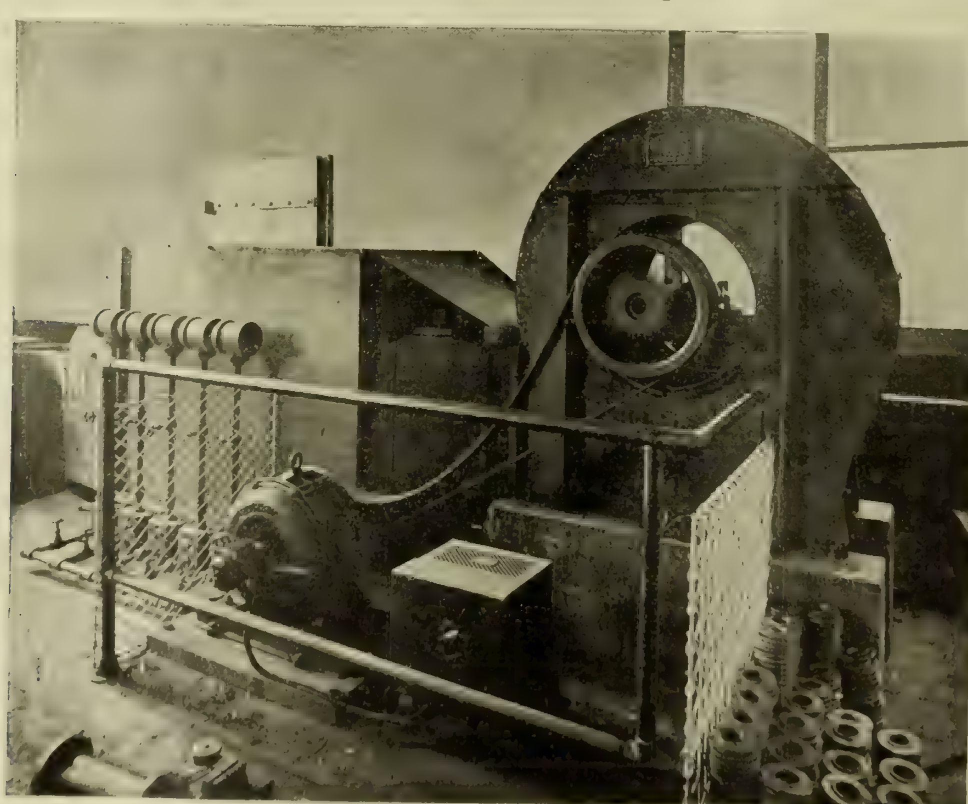


FIG.

rate of supply of such commodities. Furthermore, it was necessary to renew the lower portion of the angle-iron ring, and a new cover patch would have been to cut, shape, dress and drill out for the rivet holes in it, as well as in the boiler shell; also a $7\frac{5}{16}$ in. hole to cut for the sludge pipe connection. After fitting this plate in position by numerous rivets, it would have to be "caulked" or "fullered," and finished off neatly to leave no roughness.

To save time and yet make a thoroughly reliable repair, it was decided to build up the corroded shell and angle iron by means of a Tilling-Stevens mobile arc-welding equipment, which is embodied in a petrol-electric-driven motor lorry.

The Plan Used.

A description in outline of the plant and the method of using it is as follows: A 40 H.P. petrol engine drives the generating dynamo, the current from which supplies an electric motor in connection with the back axle to propel the vehicle when travelling on the road. For welding purposes special switch gear and resistances cut off the current from the motor and convey the electric energy by a pair of flexible cables to the electic arc at the work. On the back portion of the lorry is a twin-cylinder vertical air compressor supplying from 30 to 60 cubic feet of free air per minute at a pressure of 100 lb. per square inch, and driven by a twin-cylinder petrol motor. After standing the lorry in the nearest available position to the work (in this instance about 40 yards), the compressor was used to dress off the corroded surfaces of the steel plating by means of a pneumatic chisel, air being conveyed by a small flexible armoured hose; this operation ensured the clean condition of the shell surface for welding, which was then commenced.

Beginning the Job.

The first operation was to secure a good electrical contact for the negative side of the arc with some part of the boiler, and this was attained by slightly welding the head of a small iron bolt temporarily on to the face of the manhole collar. The cable from the negative terminal of the switchboard was connected to this bolt, whilst the other cable from the positive terminal at the lorry was joined to a simple pair of steel tongs holding the electrode. These latter are made of Swedish charcoal iron, each measuring 12 in. in length, with a diameter of $\frac{5}{32}$ in., and are smeared with a flux before using. One striking property about them is the amount of bending and twisting they will tolerate without breaking. To commence welding, the end of one of these iron pencils is pressed into the tongs, the handle of which is electrically isolated with insulating tape: the operator places a hand-observation screen of red glass before his eyes, and makes contact with the electrode and the boiler shell. On withdrawing the pencil slightly an electric arc is produced of sufficient heat intensity to fuse the electrode end, the molten particles of which are carried over on to the negative side of the arc—*i.e.*, the boiler shell, which is also rendered intensely hot at the point of contact. Great care is necessary to maintain the air gap between the electrode and the metal to be welded, the most suitable gap evidently being about $\frac{1}{8}$ in. or $\frac{3}{16}$ in. If the pencil is allowed to touch the shell for even a second or two, a complete circuit is thereby made, and as soon as the air gap ceases to exist the arc, of course, fails and the metals cool, with the result that the electrode becomes fixed to the boiler plate. It has then to be broken off, and a fresh arc struck. Under such circumstances a heavy rush of current is caused by the absence of the air gap; consequently a steadying resistance and an electrical governor are installed in the circuit on the lorry to reduce as far as possible the current fluctuations.

In doing the welding of this boiler, the switchboard at the lorry gave the following information: When no welding was being done, 50 volts, 100 amperes; when the continuous arc was being maintained during welding, 40 volts, 150-200 amperes; when the electrode was permitted to touch the boiler shell, making a closed circuit, 40 volts, 300 amperes.

A Difficulty.

When welding was done on the underneath side of the boiler shell, the electrode, in fusing, had the tendency to form molten globules, which were liable to fall off on to the bottom of the flue if the arc were allowed to play at the same point for any length of time. When this occurred the electrode was brought away from the shell, thus destroying the arc, and the soft globules of iron gently flattened against the plating with a hammer. Under average conditions it was possible to use 20 of these Swedish iron electrodes per hour, and for the building up of the boiler plate in question it took, roughly, 300 of such pencils.

Time Occupied.

To give some idea of the time taken to complete the work, the welding apparatus arrived at the colliery about noon on one day; the cables, etc., were run out to the boiler, and the corroded steel plating dressed with the pneumatic chisel in the afternoon, and half the welding done by seven o'clock that night. By the following afternoon the welding was completed, and the work smoothed off with the compressed-air hammer, whilst the front lower edges of both furnace tubes were also built up where slightly damaged through frequent stoking and raking out of fires. One fitter, with his assistant and a boy, were with the equipment and carried out everything in connection with the welding, etc.

The extent of the new metal forming the weld between the sludge-hole and the front end plate was approximately 21 in. in length circumferentially round the shell, 3 in. in width, and $\frac{1}{2}$ in. in thickness (average), the hole through the plate being completely filled up.

Cost.

The total cost of repairing the boiler by means of electric welding was £54. Although this may appear at first sight a large amount for a small repair, yet much time was saved by adopting this means of making up the original wasted plate instead of fitting a new part altogether. Further, with regard to the tensile strength of an electrically-welded joint, this may be as much as 95 per cent of that of the original unwelded metal, the average strength being frequently from 80 to 90 per cent.

Advertising Exhibition.—At the White City, in London, in November, an International Advertising Exhibition is to be held, and what Britain has to offer in the shape of the best goods will be seen.

AN AID TO DETERMINE PULLEY DIAMETERS AND SPEEDS.

By George W. Childs.

This letter is written in reference to the article entitled "An Aid to Determine Pulley Diameters and Speeds," by Julius Klein in the May 20th issue of the *American Machinist*, page 1076, Vol. 52.

The writer has had considerable experience in compiling tables, and is on the look-out for tables and data which will lessen the labour of designers and also be useful to shop men. I have made a careful study of the table edited by Mr. Klein, and am of the opinion that it will not be of any particular benefit to shop men, and certainly not to designers. The formulæ given for determining pulley sizes and speeds is published in nearly every manufacturer's catalogue of transmission machinery and in engineering handbooks; and, being the only formulæ to my knowledge which can be used for the purpose mentioned, I have no hesitancy in stating that the average mechanic is perfectly familiar with its use.

Referring to the first example given in the description, I find the following: That it takes about one-half the time to get the required answer—*i.e.*, 20 in. diameter pulley, by figuring with a pencil and paper that it does by using the table given. Computing the belt speed in feet per minute is also a very simple matter with which the average mechanic is perfectly familiar. For example, a 20 in. diameter pulley making 90 revolutions per minute, to find the belt speed in feet per minute. By referring to a table of circumferences we find that the circumference corresponding to a 20in. diameter is 62·832 in., which divided by 12 is 5·236 ft. Multiplying 5·236 ft. by 90 revolutions per minute, we have 471·24 as the belt speed in feet per minute. Then again, we will assume that the average person interested in the subject has in his possession a table giving the decimal parts of a foot equivalent to 20 in., and if he has not this can be easily computed. Solving $\frac{20}{12}$ ft. × 3·1416 × 90 revolutions per minute, we get 471·24 ft. per minute for the belt speed as before.

Referring to the second example given in the descriptive matter, we are compelled to do some computing in using the table. I found that the result 1,523·16 ft. per minute on the last line in the description is an error, and should read 1,623·16 ft. per minute. Referring to the tenth column from the right and headed 549·8 and 21 in the table, I found in trying another combination that the fifth figure from the bottom, 87·07, is an error and should evidently be 81·07.

I should say that the table as published would not be a labour saver, and the results would be hard to read. In case anyone should reproduce the table for his own use, he should by all means draw heavy lines across it, say, at every fourth or fifth line of figures.

Oil Fuel Locomotives for Spain.—There have now been imported from the United States, for use on the branch railway line running from Argamasilla to Tomelloso, in the province of Ciudad Real, the first locomotive running with petrol as a fuel. If satisfactory results are obtained, others will be imported in due course.

THE "SELCLO" VALVE.

There are a number of places where a good serviceable valve that can be depended upon to remain tight and stand the wear and tear and rough handling of inexperienced help, especially in railway roundhouses, garages, laundries, and other services where a large quantity of steam, water, or other fluids are to be handled, and where the ordinary water tap or other usual device soon wears out, or does not give sufficient quantity of supply. Messrs. Jenkins Bros. Ltd., Kingsway, London, W.C., claim these qualities for their "Selclo" valves.

POSITION OF VALVES.

It is the usual practice, when equipping railway roundhouses with blower lines, to place the valves on the under side of the roof trusses, either at the back wall or near the centre of the roundhouse, with the main and down pipes attached to posts supporting the trusses, and a similar plan is followed when installing the valves in other plants. As the valves are operated from the floor, they must be installed "upside down," with an extension rod from the wheel or end of valve-stem down to within easy reaching distance from the floor. When ordinary globe valves are used and placed so that the pressure is under the disc, with valve closed, the slightest leak at the seat causes an accumulation of water in the neck of the body to which the bonnet is attached, and if the stuffing-box is not always kept up perfectly tight the water runs down the extension rod and on to the floor, and is a source of annoyance.

METHOD OF WORKING.

The valves are usually handled by unskilled labourers, who know but little about valves or how to handle them, and the valves are apt to be closed so tightly as to injure the disc, or perhaps not closed tight enough, which causes them to leak, and the stuffing-box not being easy to get at they are apt to be neglected.

Attempts have been made to overcome these conditions by placing the valves in an upright position and operating them with gears or other contrivances, but with indifferent success. It was with the view of overcoming these difficulties that the "Selclo," or blower valve, was designed. With the outlet for the branch pipes taken from the top of the main header there can be no accumulation of water in the branch lines or in the body or neck of the valve, consequently no drainage or dripping on the floor. While the opening and closing is readily accomplished from the floor in the usual manner, no pressure other than that of the steam or water can be put on the disc in closing, because of the fact that the spindle is not connected directly to the disc-holder. For the same reason, leaks cannot occur through slight contraction of the parts when cooled.

An advantage claimed for this type of valve is that the stuffing-box and valve stem being connected to the outlet end of the body, where there is no pressure when the valve is closed, the stuffing-box can be packed at any time, or the bonnet or trimmings can be removed entirely from the body, if necessary, without disturbing the main line or shutting off the steam.

Canadian Railway Combination.—The Canadian people will own and work the biggest railway system in the world when the amalgamation of the Grand Trunk Pacific and the Canadian National Railways' has been completed. The amalgamated Canadian National Railway will control 22,000 miles of railway lines. It will employ 70,000 persons. It will own 2,000 modern locomotives, 1,800 passenger cars which can accommodate 70,000 persons, and 70,000 freight cars of all descriptions, with a normal carrying capacity of 600,000 tons. Stretching from Sydney, Nova Scotia, to Victoria, British Columbia, a distance of 4,030 miles by rail, the Canadian National will operate 1,038 miles in Nova Scotia, 279 miles in Prince Edward Island, 1,107 miles in New Brunswick, 2,496 in Quebec, 6,352 in Ontario, 2,320 in Manitoba, 3,576 in Saskatchewan, 2,090 in Alberta, 1,227 in British Columbia, and 1,881 in the United States. But the transportation system does not stop with the land equipment. The merger involves 32 ships sailing from Atlantic and Pacific ports. The Government programme calls for the construction of 30 freighters, which will bring up the total tonnage to 360,000 deadweight tons. Sixteen ships will sail out of Vancouver to India, China, Japan, Hawaiian Islands, West Indies, and Australasian ports, and the remainder to European, East Indies, and South American ports, out of Quebec, Montreal, and Halifax.

LAUNCH OF A SUPERIOR LINER FOR THE DONALDSON SOUTH AMERICAN LINE LTD.

S.S. "CORTONA."

This double-reduction-gear turbined vessel, built and engined by Messrs. Vickers Ltd. at their Naval Construction Works, Barrow-in-Furness, for the Donaldson South American Line, 14, St. Vincent Place, Glasgow, was launched on 14th September. She represents the lastest and most fully equipped type of vessel for the South American trade, and is an acquisition to the British Merchant Service.

In the construction of this vessel special consideration has been given to the general cargo trade requirements from Glasgow and Liverpool, and the vessel has all the facilities for the safe carrying and speedy handling of the usual assortment of cargo for South America.

The leading particulars of the "Cortona" are :—

Length, 414 ft. between perpendiculars.
Breadth (moulded), 55 ft. 6in.
Depth (moulded), 39 ft. 3in. to shelter deck.
Loaded displacement, 13,120 tons.
Deadweight carrying capacity, 9,100 tons.

The vessel has been designed to develop a speed of 12½ knots, and her fuelling arrangements are such that she can burn either coal or oil.

The vessel, which, despite her commercial nature, presents a handsome outline, is fore-and-aft rigged in the orthodox fashion of the Merchant Service, with two steel-pole masts, having telescopic pine topmasts suitable for the Manchester Ship Canal requirements, and arranged to carry the aerial spans for the wireless installation, which is situated aft of and adjoining the wheelhouse.

The steering-gear, which is of the telemotor-operated type, and is situated in a deck-house aft, and the steam windless, arranged on the forecastle in the usual manner, is of an improved patent (direct grip) type.

Life-saving provision is provided for the full complement of the vessel, the lifeboats, of 26 ft. length, being carried under davits on the boat deck.

The vessel has been insulated throughout by Messrs. Vickers Ltd. The refrigerating plant consists of two independent horizontal carbonic anhydride compressors, operated by compound tandem steam engines, fitted with the necessary steam and CO_2 condensers, evaporators, piping, pumps, etc., and capable of maintaining a temperature of 15 deg. Fah., or 17 deg. below freezing point, when the vessel is in the tropical zone.

Special attention has been given to the arrangements for loading and discharging, and to this end twenty derricks are fitted to serve the five main hatches, twelve of which derricks are capable of dealing with lifts of three tons each, seven of seven tons each, and the remaining one of ten tons, the eight larger derricks being arranged four on each of the two masts, and the smaller ones on derrick posts which also serve the purpose of ventilating shafts to the cargo spaces. The system of derricks is operated by twenty steam winches.

Seven transverse water-tight divisions have been arranged, subdivided by the orlop, main, and upper decks. Passengers will not be carried, but ample accommodation has been arranged for the complement of 61, which includes 16 officers, whose quarters are situated on the shelter deck amidships.

The propelling machinery consists of a set of turbines of the impulse type, driving the propeller shafting through double-reduction gearing, and capable of developing over 3,000 H.P., and embodies the most up-to-date improvements to ensure economy and efficiency on service.

A "Michell" thrust block is fitted at the forward end of the gear-case to take the thrust of the propeller. "Michell" thrust blocks of the high-speed type are also fitted at the forward end of each of the turbines for the purpose of maintaining the rotors in the correct relative position with respect to the casings and diaphragms, and to take up any residual thrust.

Steam is supplied to the turbines by four single-ended boilers of the cylindrincal type, working under forced draught and fitted with coal or oil convertible furnace fronts and superheaters. The condensing plant consists of one surface condenser of the Contraflo type, in conjunction with a set of Contraflo kinetic reciprocating air pumps combined with steam ejectors—which ensures the maintaining of a high degree of vacuum when operating under all conditions met with on service. The propeller is of the four-bladed type, the blades being of bronze and the boss of cast steel.

The auxiliary machinery installed includes a separate winch condenser of the Contraflo surface type with circulating pumps, feed heaters, cascade feed-water filter, and float tank of the firm's manufacture. A "Morrison" evaporator is provided for the purpose of supplying fresh water to the ship.

THE INDUSTRIAL LEAGUE AND COUNCIL'S VIEW OF THE UNEMPLOYMENT PROBLEM.

Whilst on all hands we are hearing of the possibilities of a black winter fraught with disastrous periods to the working man as a result of unemployment and the hardships which follow in its train, indications are simultaneously accruing that the prognostications of the pessimists will in a measure mature unless drastic action is speedily taken to deal comprehensively with the great unemployment problem. In tackling the problem, we realise it is equally incumbent to make the workers appreciate their responsibilities to the question in finding a permanent solution to it, as it is the leaders of industry, employers and trade unionists.

The Industrial League and Council, realsing the importance of bringing as much light to bear on the subject as possible, devoted a recent week-end to its consideration. A number of prominent representatives of labour and employers accepted the invitation of Mr. H. V. Roe to spend the week-end with him at Givons Grove, Leatherhead, in order to thrash it out.

The discussion was opened by Mr. H. V. Roe, who read a very logical and closely-reasoned paper on "Unemployment and Bankruptcy: The Spurs to Progress." Every issue involving unemployment that could be thought of was introduced and debated from the point of view of each—of the labour as well as the employer representatives in attendance—and the conclusions which were ultimately come to were: That this conference of employers and employed, after thoroughly discussing Mr. H. V. Roe's paper on "Unemployment and Bankruptcy: The Spurs to Progress," are of opinion that:

1. Each industry should form a joint industrial council of employers and employed at which all the incidents of unemployment should be thoroughly and scientifically investigated.

2. Each industry should decide whether it is possible for the industry to maintain and supervise its own unemployed.

3. The representatives of all the joint industrial councils should then meet and consider whether unemployment should be settled by each industry or by all industries as a whole.

Pyrometers.—We have received from The Automatic and Electric Furnaces Ltd. particulars of new pyrometric and thermo couples which they are placing on the market.

New Steel Making Process.—M. Lucien Basset, a Parisian engineer, is reported to have completed a process by which steel can be produced direct from iron ore, without the trouble and expense of manufacturing pig-iron as an intermediate product. A company (with a nominal capital of 60 million francs) has been formed to work the idea, and it is stated that six furnaces of 250 tons daily capacity may be shortly erected at Longwy, and still larger establishments opened in Normandy. British manufacturers will take more than ordinary interest in this, as they did not anticipate France would be a formidable rival in the steel trade.

CAMS.

By W. E. Bennison, A.M.I.M.E.

(Continued from page 12, August 7.

Interdependence of Cams.

Many machines have more than one cam. Some automatic machines have many cams. It is seldom that one cam in such a machine can be dealt with independently of the rest, for each cam performs one operation out of a series, and each operation bears some relation to the others. It follows that each cam must have a definite relationship to the other cams in the matter of time, and that the time of the whole series will have to be studied in respect to its parts. It is not possible to give any definite rules to follow in designing a set of cams for such a machine, because so many various conditions are encountered; yet one of two principles, which should make the problem easier, may be followed in a large number of cases.

To commence with, it is a great advantage if all the cams are mounted on the same shaft. Those which, for various reasons, have to be carried on other shafts can be connected to it by gearing, and so their motion will bear a definite relation to that of the main cam shaft.

The times of all movements should be referred to the cam shaft, one revolution of that shaft being

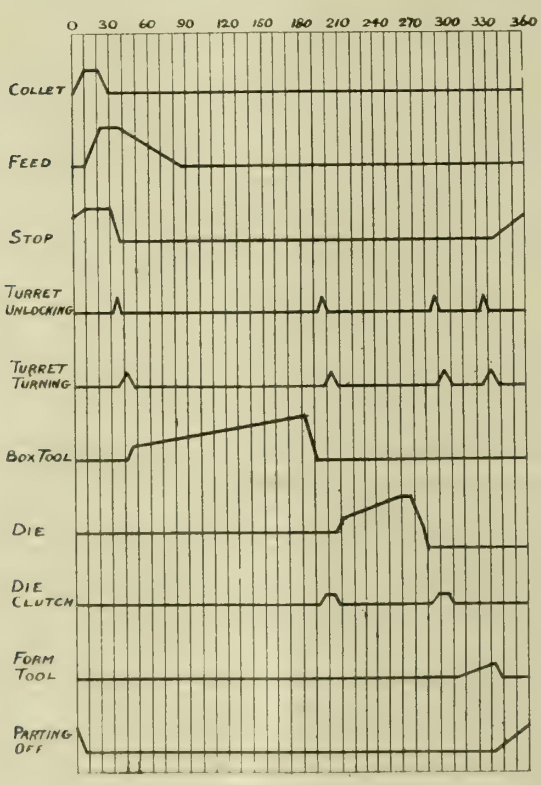


Fig. 80.

taken as the standard. Thus all the motion angles can be set out in one diagram.

The Time Chart.

The time must be divided out between the various cams according to the operations which they have to perform. In the majority of cases, one revolution of the cam shaft is equal to one complete cycle of operations, therefore 360 deg. will have to be apportioned out to the various motions. The best method is to construct a time chart for the machine. Such a chart will show exactly what the machine is doing at any moment, and is really a combination

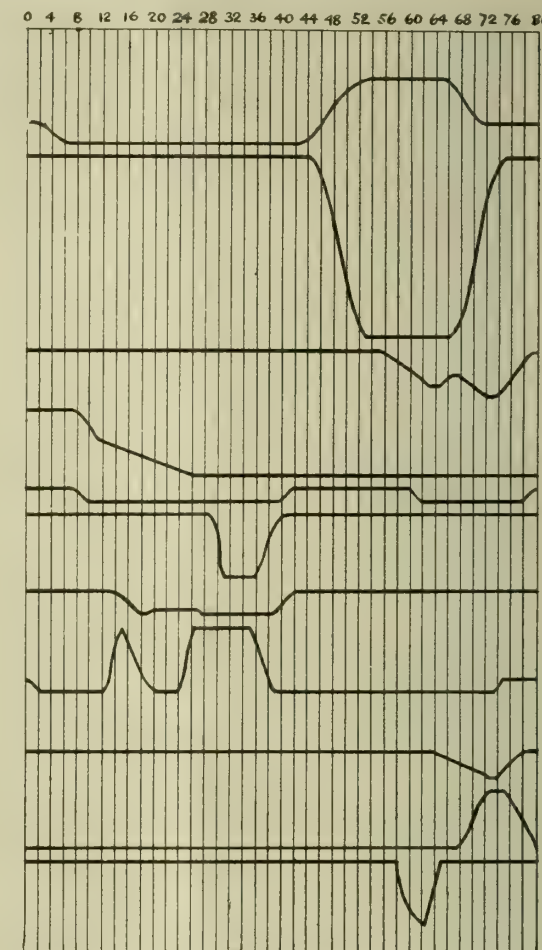


Fig 81.

of the time diagrams of the various cams. Typical examples are shown in Figs. 80 and 81. The abscissæ, of course, represent time in angular velocity of the camshaft. The width of the diagram is 360 deg., and it may be spaced out into degrees or into any number of equal parts, whichever is most convenient. The ordinates represent distances travelled by the followers. Each curve represents the movement of one follower. If one cam actuates several followers there would be a curve for each follower. To construct the diagram a convenient point is selected in the cycle to serve as a datum in the matter of time for all the operations, and all times are referred to that point. It is represented in the chart by the vertical line O which forms the left-hand limit of the diagram. All the curves are traced from this line, the positions of the ordinates all being measured from it. An ordinate drawn at any part of the diagram will show exactly what the machine is doing at the moment represented by the distance of such ordinate from O; for the intersection of the ordinate with each curve denotes the position of the

follower at that moment. Fig. 80 shows a time chart which was constructed for an automatic turning machine. As most of the motions were uniform they could be represented by straight lines, and for the rest it was sufficiently accurate for the purpose in view to represent them by straight lines also. For datum was taken the moment when the collet commences to open. Commencing at the top of the diagram and descending, it will be observed that the collet takes 9 deg. to open, remains open for 13 deg., and closes again at 31. deg. The feeding of the stock commences at 8 deg., and finishes at 23 deg. The stop commences to move forward near the end of the cycle at 333 deg., and is full out at 10 deg. just when the collet is full open. The next two curves show the times of unlocking and turning of the turret. The box tool commences to move forward quickly while the turret is turning for the first time; at 44 deg. when up to the job it commences its slow cutting motion, which it finishes at 183 deg., returning quickly to allow the turret to turn. The screwing operation takes place immediately after the turret turns again, the die advancing quickly at first until up to the job, and then at the correct speed for screwing; the return is much quicker owing to the reversing of the spindle during the unscrewing. The die is driven by a clutch, and the next cam shows the times of engaging and disengaging of this clutch. The form tool commences to move at 302 deg. and finishes forming at 333 deg. returning quickly in 8 deg. The parting-off tool commences the moment the form tool has finished (at 333 deg.), and the job is parted off at 360 deg.; the parting-off tool returns from 0 deg. to 8 deg.

If a vertical line is drawn through this chart at 5 deg. we learn that at that moment the collet is opening, the stop advancing, and the parting-off tool returning. A vertical line at 120 deg. shows that the box tool is cutting: one at 330 deg., that the turret has just unlocked, is turning, and the form tool is cutting.

Fig. 81 is the time chart for the linotype composing machine. One or two curves have been omitted for the sake of not complicating the diagram too much. In this case, the chart is divided into 80 equal parts. Although the timing is complicated and involved, the chart serves well to illustrate the principles. If any vertical is examined it will be seen that there are usually several movements going on at the same time. Thus line 70 indicates that six movements are taking place simultaneously at a time $\frac{70}{80}$ of a revolution from O.

The Time Diagram.

A circular time diagram is often useful when the machine is not too complicated. Such a diagram is shown in Fig. 82. Any line, say the vertical line OX, is taken as the datum. The angle for each operation is marked off from this line in the direction opposite to that of rotation. Fig. 82 is the circular diagram for chart Fig. 80, but several operations are omitted in order not to complicate too much. It will be noticed that this diagram does not show any of the movements, but merely the time of the commencement and the duration of each operation. If a circle be drawn and divided into degrees, the operation being performed at any instant can be readily seen. The circular diagram does not give as much information as the time chart, but it shows the complete cycle in sequence, and is useful in fixing the positions of keyways.

As in the case of the individual cam, so with the complete machine, it is not possible to fix all the

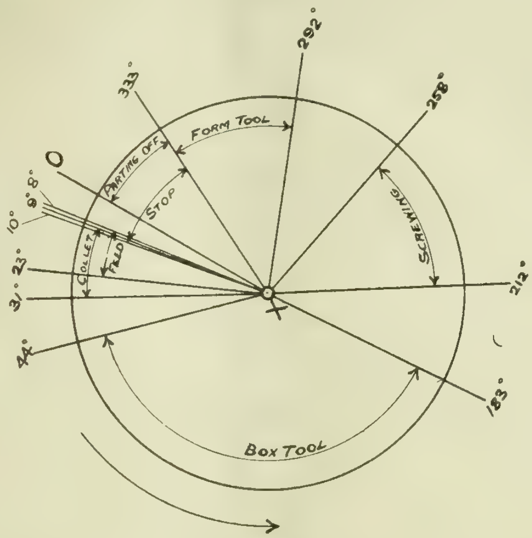


FIG. 82.

factors at once. It is, therefore, best to lay out a provisional chart first from which the preliminary cam layouts can be made; then the chart can be rectified, and again the cam layouts, until every curve is satisfactory, and the whole series properly correlated.

COMPANY NOTES.

MOTOR MANUFACTURING FUSION.

The announcement in June that A. Darracq & Co. Ltd. and the Sunbeam Motor Co. Ltd. were to unite created great interest in the motor trade. Further interest is now aroused by the announcement that the absorption of the W. & G. Du Cros Co., makers of the W. & G. commercial lorry, is taking place. The formidableness of the amalgamation will be recognised when it is recalled that it now includes the Clement-Talbot Motor Co., which was taken over by the Darracq Co. some time ago, and also the firms of Heenan & Froude, engineers, of Worcester and Manchester, and Woodhead & Sons, engineers, Leeds.

BRUSH ELECTRICAL ENGINEERING CO. LTD.

For an issue at par of 339,512 ordinary shares of £1 each of the above company, whose factories are situated at Loughborough, is one of the oldest established undertakings in the electrical engineering industry. Its most important speciality is the Brush-Ljungstrom Steam Turbine, which is in great demand on account of its low steam consumption and other advantages. The company's gross profit in 1918 was £157,799, and in 1919 £223,966. The devidends paid in 1918 and 1919 were 19 per cent and 15 per cent respectively. As every department of the factory is fully occupied with orders, the maintenance of the dividend appears well secured, apart from the additional earning power of the new capital.

CALCUTTA ELECTRIC SUPPLY CORPORATION.

Share capital, £3,000,000 in 600,000 £5 shares—220,000 shares issued. Issue of £500,000 5 per cent 1st mortgage convertible (registered) debentures, free of tax, at 95 per cent. The company reserves the right to redeem the whole of the issue any time up to June 30th, 1925, at 102 per cent, and also the right to issue further debentures up to the limit of half the subscribed share capital. The profit has been gradually increasing from £8,646 in 1901 to £237,206 in 1919. The assets of the company total £2,039,723, including £220,347 in Government stocks and £176,087 cash in hand.

American Engineering News.

[By Our Own Correspondent.]

The following extract from *The World's Markets* should be of interest to British engineers :—

"The tremendous increase in the demand for American machinery may be traced to three causes : (1) the world-wide need of labour-saving machinery, (2) the adaptability of American machinery for almost every purpose, and (3) its low cost, due to American methods of quantity production."

The same writer goes on to say, "In Australia, the manufacturers of this country (U.S.) are having little difficulty in competing with English manufacturers, in spite of the fact that the latter enjoy a distinct advantage because of the tariff." Well ! if all this is true, it's your handicap.

* * *

Apropos the question of machinery, the same worldly-wise journal carries this bit of information as valuable on one side of the Atlantic as the other. "The American agricultural tractor has invaded the Philippines in force. During the fiscal year just ended, over 800 tractors of various types have been sold in the Archipelago, and there has been a fairly general scramble on the part of importers of farm machinery and similar products to get the agencies of promising American makes. The tractor propaganda is in the air and Philippine planters are generally open to conviction on the proposition that it will solve the pressing need of Philippine agriculture for more abundant and more effective power." Idon't know, off-hand, whether there is a tariff preference for American made machinery in the Archipelago. If there is no preference, here is a chance to "go to it," and may the best win.

* * *

We have an organisation in San Francisco known as "The World Trade Club." It does nothing much but send out propaganda looking to the adoption of the metric system by the United States. In conjunction with the American Metric Association of New York, the "club" has caused more than 57,000 petitions to be sent to the Government in Washington in favour of the change. South America has had compulsory metric measurements and weights for a long time, yet there remain between one and two hundred of the old units in common use to-day.

* * *

Recently there went out of the port of Philadelphia a cargo of anthracite coal to Norway, and owners of anthracite mines, which are mostly in the State of Pennsylvania, think this will be the first of many. The cargo was what are known as "steam sizes," and the trade declares 1,000,000 tons for this purpose can be shipped at once. One coal company has 500,000 tons stored in its yards near Philadelphia.

In our anthracite mining industry these steam sizes are often a dead weight on the hands of the owner, being carried at an expense that must be paid by the consumer of other sizes. Hence, strange as it may seem, it is maintained that exports of this sort will reduce the price of other kinds of coal in the home market.

* * *

The Bureau of Mines has issued a report on "Dangers from Explosive Fumes in Metal Mining," and a technical paper entitled, "The Properties of some Stoneware Clays." The latter work has special reference to possible uses of these clays in making chemical stoneware, but many of the results brought out can be applied to other industries.

* * *

During July, 1,106 companies, each with a total authorised capital of 100,000 dols. or over, were incorporated under the laws of the principal States, the total capital represented being 1,260,418,600 dols., while in June this year there were 999 concerns which took out charters involving 1,323,221,400 dols.

* * *

During our fiscal year ended June 30, exports of iron and steel products were valued at 932,675,866 dols. compared with a total of 1,065,021,193 dols. for 1919 and 1,125,889,371 dols. for 1918, and with 1,133,746,188 for 1917.

For the year ended June 1920, 4,212,732 tons of iron and steel were exported, against 5,181,951 tons for 1919 and 4,862,154 in 1918.

* * *

When Manchester and her merchants took the Liverpool and railway bull by the horns, and constructed the Ship Canal, they did a work which, even to-day, and despite advertising, is not nearly as well known in America and other places as it ought to be. I have during many years used the undertaking as a splendid example of commercial courage and vision, in articles, in papers I have read before the trade conventions, and in my Government reports.

* * *

This is by the way of leading up to saying that Chicago is preparing to follow Manchester's example, though in a less ambitious fashion. Only a barge canal is projected, though the fathers of the project fondly and grandiloquently refer to the undertaking as "Chicago's Panama Canal," by which is meant that with the 20,000,000 dols. appropriated by the State of Illinois, an eight-foot channel is to be dug through to La Salle, involving also the building of five locks. The present 22 ft. lock in the Chicago Drainage Canal is to be replaced by one of 110 ft. width and 600 ft. long. Four other locks of the same size are to be placed along the sixty-five miles of the canal. The channel will vary in width from 200 ft. to 270 ft. Fleets of barges drawing six to seven feet are to be used.

* * *

Some of the advantages the Chicago territory expects to gain from the new waterway are outlined by Mr. M. G. Barnes, chief engineer of the State Division of Waterways, who points out that goods now paying a railroad rate to New Orleans of 8·50 dols. a ton will be carried by canal for three dollars the ton, and that within a year of opening there should be carried by the new route not less than 10,000,000 tons of traffic a year.

* * *

St. Louis, of course, has the Mississippi River connecting it with New Orleans, and as a consequence, Mr. Barnes says, corn brings a higher price in that city than in Chicago during normal times, because it enjoys a differential of seven cents a bushel to Liverpool by water (and presumably to Manchester) lower than the rail via New York rate. However, going into savings of this sort with Lancashire folk is like carrying coals to Newcastle.

* * *

One effect of the long-continued coal shortage has been to strengthen the national interest in undeveloped water powers. Scores of millions of horse-power are running to waste in the country. It is estimated that in the New England section alone 2,000,000 H.P. is available. Indeed, New England could, in a very great measure, avoid the industrial upset she has been suffering from, caused by coal shortage, if she would develop these latent resources. And New England industries are a long, long way from the coal mines.

* * *

As with England, our coal problem is a continuing cause of uneasiness. But a few days ago Mr. J. D. A. Morrow, vice-president of the National Coal Association, said that the nation is now emerging from a crisis in its soft coal supply, which, until the last few weeks, threatened its whole economic life. Only by bringing into play stupendous efforts on the part of the bituminous coal owners and the railroad executives, who were backed by the Inter-State Commerce Commission, had a dire emergency been met and an industrial calamity avoided.

* * *

Then again the fuel situation is aggravated by an announcement from White Sulphur Springs, West Virginia, that a sharp curtailment of the sale of natural gas to industries, as well as to domestic consumers, will have to be effected during the coming winter.

* * *

Estimates by the United States Geological Survey indicate commercial stocks of bituminous coal in the country at 20,000,000 net tons on June 1st. Being less than the stocks carried on October 1st, 1916 and 1917, and much less than stocks on hand at the close of 1918. In three months, from March 1st to June 1st of this year, stocks decreased 4,000,000 tons, or 17 per cent. The reserve on June 1st was sufficient for only two weeks and one day.

* * *

A company formed in Rome, Italy, for the purpose of electrifying the Italian railways, and for producing materials and machinery for that purpose, all to be made in Italy, has obtained most of its capital in America as a result of negotiations conducted by Marquis Cusani-Confalonierie, former Italian Ambassador in Washington.

* * *

Price reductions in building materials have not been the attractive bait they were expected to be by the producers and dealers who made them. The market remains inactive. Buyers believe prices will go lower, and in a market as uncertain as the present one timidity is the outstanding feature. For although building activities in 117 cities show gains during August, building interests are undoubtedly acting with unusual caution.

Trade Items, Notes, &c.

Professor John Bretland Farmer, D.Sc., M.A., F.R.S., Imperial College of Science and Technology, has been appointed by an Order of Council dated the 28th day of August, 1920, to be a member of the Advisory Council for Scientific and Industrial Research.

The Healey Gear.—Engineers as well as motorists will watch the progress of the Healey gear, a set of which is being made in the workshops of the British Variable Gears Ltd., who own the rights of this invention. The gear is of simple construction, and it is hoped that the time may arrive when motorists will be able to have not only four, but possibly ten different gear ratios to assist the engine to give greater road efficiency.

Messrs. Mavor & Coulson Ltd., Mile End, Glasgow, have just issued a revised catalogue of their well-known switchgear. It is a handy loose-leaf catalogue of about 30 pages with numerous illustrations. They state that, owing to present conditions and the still unsettled prices of raw materials, they cannot give a fully-priced list, but will be pleased to quote to enquiries.

Engineering Supplies for Australia.—The Department of Overseas Trade is in receipt of a communication from the Manufacturing Engineers' Association of Melbourne, Australia, to the effect that they are interested in particulars of machine tools, drills, cutting wheels and milling cutters, and all manufacturing engineers' stores and supplies. They would value copies of United Kingdom manufacturers' catalogues, together with prices of machinery required in the equipment of their factories. Such catalogues, which should be forwarded direct to the Association, would be included amongst the books in the library of the Association, where they would be available for reference by members.

Owing to continual expansion, Messrs. The Cambridge & Paul Instrument Co. Ltd. have found it necessary to centralise their business organisation in London. Their head offices and showrooms are at 45, Grosvenor Place, S.W.1. The showrooms will contain a wide and varied selection of instruments, both scientific and industrial, and users of such will be welcomed at any time during business hours. A permanent exhibition of this nature should make a wide appeal. It is an ambitious attempt to place the fullest information before the foreign visitor on a tour of inspection, and also the prospective buyer in this country. The new premises are conveniently situated, since they are within a hundred yards of Victoria Station, and can be directly approached from every part of London.

Oil from English Wells.—Petroleum companies now exhibiting at the Crystal Palace were told by Lord Cowdray that a public man said recently that he would drink all the oil found in England. That man, said his lordship, would find it difficult to drink the five tons of oil which the Hardstoft well is now producing daily. That is as large a production as the average well in America. We were now producing oil in England and Scotland. At the same time Mr. F. C. Kellaway, M.P., said that, with a consumption of six million tons of oil annually, the British Empire only produced two million tons. Last year 75 million tons of crude oil was produced, of which the American output was 54 million tons. About £450,000 had been spent in sinking wells in this country; eleven wells had been started, and three were now actually drilling. The home policy was to prevent indiscriminate drilling, and he hoped to make an important announcement on the subject shortly.

The Institution of Automobile Engineers.—The following is a list of meetings which will be held during the month of October under the auspices of the Institution of Automobile Engineers:—Wednesday, Oct. 13th.—First meeting of the session of the main Institution at the Royal Society of Arts, John Street, Adelphi, London, W.C., at 8 p.m., when Sir Henry Fowler will deliver his presidential address. A card of invitation will be sent on application to the Secretary, 28, Victoria Street, London, S.W.1. Thursday, Oct. 14th.—First meeting of the session of the London graduates at 28, Victoria Street, London, S.W.1, when Messrs. Chatterton and Watson will read a paper on "Factors Affecting Power Output." Monday, Oct. 18th. Meeting of the Scottish Centre at the Royal Technical College, Glasgow, at 7-30 p.m., when Sir Henry Fowler will deliver his presidential address to the Scottish members. Wednesday, Oct. 20th.—Meeting of the Birmingham graduates' branch at the Chamber of Commerce, New Street, Birmingham, at 7-30 p.m. Paper by Mr. V. A. Ford on "Die-Castings." Wednesday, Oct. 27th.—Annual dinner of members of the Institution at the Royal Automobile Club, Pall Mall, London, at 7-30 p.m. Thursday, Oct. 28th.—Second meeting of the session of the main Institution at the Chamber of Commerce, New Street, Birmingham, at 7-30 p.m., when Mr. C. H. Savage will read a paper on "The Springing of Motor Cycles." A card of invitation may be obtained on application to the Secretary, 28, Victoria Street, London, S.W.1.

Preparing for Road Trains.—Many important provisions are contemplated in the New Road Traffic Bill, which has been prepared by the Motor Legislation Committee and sent to the Ministry of Transport. The principal modifications of the law proposed are briefly as follows:—(1) Maximum weight of heavy and ordinary motor cars, (2) registration of all classes of mechanical road vehicles, (3) drivers to have driving licences, (4) abolition of general speed limit of motor cars and of speed limit in certain areas, (5) endorsement and suspension of driving licences, (6 and 7) penalties and restriction of traffic over bridges. For locomotives the Minister of Transport will make regulations in regard to weight laden or unladen, width, design, diameter, and base of wheels, and width and design of tyres. The Bill proposes six miles an hour, or three miles per hour in any populous place as the rate of speed, in place of two miles per hour for road locomotives at present. The maximum number of trailers is prescribed not to exceed three (excluding the water-cart), but "the council of any county or county borough may, upon such terms and conditions as may be agreed, authorise the owner of any locomotive to draw additional trailers within the area or of any part of the area of such county or county borough respectively." But an important provision is in another clause which says that where a locomotive draws more than two trailers, only one man shall be in charge of the rear trailer, with means of communication with the driver so that oncoming traffic, etc., may be signalled and assisted and directed. This reduces the number of persons who at present have to be in attendance with a locomotive drawing several trailers. Under clause 41 a road locomotive is defined to mean a vehicle propelled by mechanical power which does not exceed 14 tons unladen, or such greater weight as the Minister of Transport may from time to time prescribe. A heavy motor car is to be taken to mean a vehicle propelled by mechanical power which exceeds 50 cwt. in weight unladen, and does not exceed 6½ tons in weight unladen, or such weight as the Minister may prescribe. Emission of smoke or visible vapour is to be made a new offence under this Bill.

The New Two-cycle Marine Engine: Vickers Ltd. not Alarmed about the American Discovery.—"The Schwab discovery alarms me not at all. When motor ocean liners become a commercial possibility, British shipbuilders need not send their orders to America." This is what was said to a Press representative early in September by Sir Trevor Dawson, vice-chairman of Vickers Ltd. He was referring to the claim by Mr. Charles Schwab, of the Bethlehem Steel Co., of America, that his firm can produce a new two-cycle marine engine as powerful as a four-cycle engine twice its size. Further, that two-thirds of the present fuel cost will be saved as compared with the steam-driven oil-fired vessel. Sir Trevor Dawson said that Vickers had been experimenting for some time with a two-cycle marine engine, and did not admit for a moment that Schwab had beaten them. He continued:—"We are well up with him in every single particular, but our opinion is that at present the four-cycle marine Diesel engine is preferable to the Schwab 'discovery.' It is simpler, and requires much less technical skill *en route*. Further, the two-cycle engine requires a considerable amount of auxiliary apparatus." "I believe," he added, "that motor-driven passenger liners are an engineering possibility, but vast experiments will be necessary before such ships will attract passengers. The new motor tanker, Narragansett, which Vickers engined, cannot be surpassed by America. This ship kept up an average speed of 11·1 knots across the Atlantic, and its total oil consumption was 12 tons daily. In a coal-fired vessel 50 tons of coal would have been consumed daily. This vessel is driven by our new motor engines, is of 10,050 tons dead-weight capacity, and has a bunker-oil capacity of 733 tons. It will carry a cargo of 9,420 tons of oil, and will help Britain to get her share of America's oil output of 412 million barrels a year. The two main engines have a total of 2,500 B.H.P. All this is accomplished at a cost hitherto believed to be impossible."

Foreign Notes.

Construction of Two New Steamers.—The New South Wales Government dockyards at Walsh Island have contracted to build for the Sydney Ferries Ltd. two harbour steamers at a cost of £110,000. One, which is designed to carry 2,000 passengers, will be the largest in the Sydney Harbour services. Her displacement will be 800 tons, speed 13 knots, and length overall 190 ft. The other vessel is intended for vehicular traffic.—Reuter.

American-Built Tankers for British Firm.—The Bethlehem Shipbuilding Corporation will start the construction this month of two 8,400 deadweight ton tankers for the Lux Navigation Company of London. The new vessels will be 427 feet long and 53 feet 1 inch in breadth. They will be driven by triple expansion engines at a speed of 11 knots. The vessels will be constructed for Lloyds 100 A1 classification, and will carry 7,600 tons of oil.—Reuter.

Chantiers Navals Belges.—Under the title of Chantiers Navals Belges a new company has been formed, with headquarters at Antwerp, to carry on the construction and repair of ships, boilers and machines as well as general mechanical construction. The 2,500 shares of Fc.500 each, representing the capital of Fc.1,250,000, have been subscribed and paid up to the extent of 20 per cent. Furthermore, 2,500 shares, ranking for dividend, but without any designation of value, have been allotted, share for share, to subscribers.—Reuter.

British Company Orders Six Tankers in U.S.—The Anglo-Saxon Petroleum Co. Ltd., of London, has placed orders for six tankers with two Californian shipbuilding yards. Three of the oil carriers, which will have a gross register of 5,250 tons, will be produced by the Union Construction Co., of San Francisco, while the South-Western Shipbuilding Co. at San Pedro will build the same number. The Standard Transportation Co., the subsidiary of the Standard Oil Co., of New York, has ordered another tanker from the New York Shipbuilding Corporation.—Reuter.

Proposed Construction of New Canal for Montreal.—Canadian shipping interests are in favour of the proposed barge canal between Montreal and St. John, Quebec. The proposition will be put before the International Joint Commission, which is to meet in Montreal in October to consider St. Lawrence River developments. At present Montreal is 458 miles from New York by canal and river. The route is now 46 miles down the St. Lawrence River to Sorel, Quebec, then 412 miles up the Richelieu River to Lake Champlain and the Hudson River. By cutting a canal through the 20 miles between Montreal and St. John 108 miles would be saved, or a net gain of 88 miles.—Reuter.

Russian Electrical Development.—Professor Lomonossow, head of the Russian Traffic Department, is at present staying in Berlin, and has made the following statements to a German Press representative: "Russia wants 5,000 locomotives, which, if possible, will have to be obtained from America and Germany. German prices are, however, too high, and the Soviet Government will, to its regret, probably be compelled to offer the orders to Canada." Referring to plans of the Soviet Government for the unification of the electric power-stations of Russia, Professor Lomonossow said that three such stations were at present being formed, the first on the River Svir, which connects Lakes Ladoga and Onega, the second on the River Volkhov, and the third North of the Black Sea, on the Dnieper, between Ekaterinenburg and Alexandrovsk. An obstacle in the way of the unification of the electrical system was the shortage of water turbines, the only countries really able to deliver which were, the Professor is reported to have said, America, Germany, and Sweden.—Reuter.

Important Merger of American Patents.—A contract is announced by which the American Telephone and Telegraph Co. and the General Electric Co. pool their patents for the benefit of each other and for the public good. The agreement, according to Mr. H. B. Thayer, president of the former company, was first proposed by the United States Bureau of Steam Navigation, which pointed out the possibilities for improved service which would result. The world wide service of the Radio Corporation of America, in which the General Electric Co. is interested, will be available for co-operation with the nation wide service of the Bell Telephone Co. It is expected that it will soon be possible to converse wirelessly with passengers at sea, and to do this through the ordinary desk telephone. Communication ultimately with Europe by the same means is predicted. The arrangement will also render it possible, according to Mr. Thayer, to conduct several conversations over one wire by the employment of different types of vacuum tubes.—Reuter.

Electrification of Austrian Railways.—Reuter's Agency learns from well-informed sources that the Austrian Government has worked out very far-reaching projects with regard to the exploitation of the water power of the country, especially in connection with railways. Colonel Causey, one of the expert advisers sent by the United States to Austria, has just returned from an inspection of the work in connection with electrifying the Tyrol lines and the Austrian State railways. He speaks in very favourable terms of what has already been done. In an interview published in the *Neue Freie Presse* he says:—"What impresses me much is that the Austrian Government, by starting the exploitation of water power and by electrifying the mountainous sections of her railways, is showing to the world her capacity for forming a creative programme of vital importance for the future of the State, in spite of the difficult and unsuitable political and social conditions of the country. Very much credit must be given to the excellent engineers and other representatives of the Government. The electrifying of the lines from Innsbruck to the Swiss frontier will mean an annual saving of 150,000 tons of coal, and, besides, there will be a saving of 16 per cent of the amount of coal formerly required for the transport of coal to the various centres where it was required. In addition, the same power station will serve all the industries in its vicinity. Lastly, there is no doubt that electric locomotives are far more effiecient than steam engines."

Mortgages, Charges, Satisfactions.

Magic Appliances Ltd.—Particulars of £2,000 debentures authorised July 27th, 1920, whole amount issued, charged on the company's property, present and future, including uncalled capital.

Tees-side Electric and Plumbers' Stores Ltd.—Mortgage dated Aug. 26th, 1920, to secure all moneys due or to become due from company to London Joint City & Midland Bank Ltd., 55, Lower Reed Street, West Hartlepool.

South-Western Engineering Co. Ltd.—Debenture dated Sept. 9th, 1920, to secure £2,000 charged on company's property, present and future, including uncalled capital. Holders:—J. Watt, Sangley Estate Office, Bromley Road, Catford, S.E., and E. C. Stansbury, 6, New Square, Lincoln's Inn, W.C.

Christopher Pratt & Sons Ltd.—Particulars of £15,000 debentures authorised Sept. 1st, 1920, whole amount issued, charged on the company's undertaking and property, present and future, including uncalled capital.

Blackstock Engineering Co. Ltd.—Charge on various properties in Enfield, dated Aug. 20th, 1920, to secure all moneys due or to become due from company to London County, Westminster and Parr's Bank Ltd.

Knight and Kendall Ltd.—Particulars of £2,000 debentures authorised August 17th, 1920, amount of present issue £650, charged on the company's property, present and future, including uncalled capital.

C. R. Garrard Ltd.—Mortgage on 107, High Street, Upper Sydenham, dated Sept. 1st, 1920, to secure £1,300. Holder: W. Smith, Brightside, Aylestone Road, Leicester.

Midland Motor Cylinder (Aluminium) Co. Ltd.—Satisfaction in full on July 27th, 1920, of charge dated Feb. 28th, 1918, securing an undefined amount.

Clement Stevens Pneumatic Engineering Co. Ltd.—Particulars of £5,000 debentures, authorised July 14th, 1920, whole amount issued, charged on the company's undertaking and property, present and future, including uncalled capital.

Alden Engine Co. Ltd.—Debenture dated Aug. 30th, 1920, to secure all moneys due or to become due from company to Barclay's Bank Ltd. charged on the company's undertaking and property, present and future, including uncalled capital.

Brook Motor & Engineering Co. (Manchester) Ltd.—Equitable mortgage dated Sept 1st, 1920, to secure all moneys due or to become due from company to Union Bank of Manchester Ltd., charged on Crown Works, 36 & 38, Crown Street, Hulme, Manchester, and land forming site thereof.

Paull's (Engineers) Ltd.—Mortgage on leasehold premises at Fore Street, Fowey, Cornwall, dated Aug. 30th, 1920, to secure all moneys due or to become due from company to Lloyd's Bank Ltd., not exceeding £800.

New Companies.

R. Macdonald & Co. Ltd. Private company. Registered in Edinburgh July 31st. Capital, £4,000 in £1 shares. To acquire the business of R. MacDonald & Co., plumbers, gas fitters, tin, zinc, brass, copper and other metal workers, etc. The first directors are H. Hill and J. T. MacDonald. Registered office : 22, Russell Street, Wishaw.

Central Electrical Engineering Co. Ltd. Private company. Registered August 4th. Capital, £100 in £1 shares. To acquire the business carried on at 26, Paradise Square, Sheffield, as the Central Electrical Engineering Co., and to carry on the business of electrical and mechanical engineers in all its branches. J. H. Horner is sole director. Registered office : 26, Paradise Square, Sheffield.

Marine and Mechanical Electric Welding Co. (Cardiff) Ltd.—Private company. July 16th. Capital, £20,000. Directors : C. M. Burls, T. McLellan, A. Woodward, and W. Pollock. Registered office : 3, Lloyd's Avenue, E.C.

Saunders & Connor (Barrhead) Ltd. Private company. Registered August 7th. Capital, £60,000 in £1 shares (20,000 8 per cent cumulative preference). To take over the business and assets of Saunders & Connor, of Barrhead, in Glasgow, to carry on the business of sanitary, hot and cold water, electrical, mechanical, ventilating and general engineers, founders, manufacturers of sanitary appliances, etc. The first directors are : J. Stewart, T. M. Saunders, W. Murray, S. Ewart, J. W. Ewart, G. H. Ewart, and W. Harrison. S. Ewart is chairman. Registered office : 25, Bloomsbury Square, W.C.

Fine Castings Ltd. Private company. Registered August 6th. Capital, £25,000 in £1 shares. To acquire from S. Milsom certain hereditaments and premises at Fishponds, Bristol, and to carry on the business of founders, constructional, hydraulic, motor, sanitary, and mechanical and electrical engineers, manufacturers of motor cars and parts, etc. The first directors are : J. Furneaux, Mrs. M. S. Hall, A. H. R. Fedden, and P. F. C. Williams. Registered office : 24, Baldwin Street, Bristol.

Carbonex Ltd. Private company. Registered August 7th. Capital, £2,500 in £1 shares. To carry on the business of engineers, founders, machinists, smith, chemists, and patentees. Life directors : E. R. R. Starr and E. R. Goodfellow. Registered office : Broad Street House, New Broad Street, E.C.

Gerritsen Ltd. Private company. Registered July 27th. Capital, £79,000 in £1 shares. To carry on in Russia, Siberia, and elsewhere the business of manufacturers of and dealers in agricultural and other machinery, dealers in provisions and agricultural produce, importers, exporters, etc., and to adopt an agreement with H. J. Gerritsen and others. The first directors are : H. J. Gerritsen, N. Van Lessen, L. A. Benham, A. J. Harris, and A. C. T. Frost. The office of a director shall be vacated if he ceases to be a director of Oetzes & Gerritsen Ltd. Secretary : A. C. T. Frost. Registered office : 45, Tooley Street, S.E.1.

S. A. Impulse Starter Ltd. Private company. Registered July 27th. Capital, £600 in £1 shares. To adopt an agreement with J. R. M. Stanfield and J. F. Adye, to develop the patents mentioned therein (not defined). The permanent directors are : J. R. M. Stanfield and J. F. Adye. Qualification, £10. Registered office : 77, St. Mary Street, Cardiff.

John King & Co. (Leeds) Ltd. Private company. Registered July 27th. Capital, £20,000 in £1 shares. To take over the business of engineers carried on by J. King and M. Kitchin, at West Bar Chambers, Boar Lane, Leeds, and elsewhere, as "John King & Co." The permanent directors are : J. King and M. Kitchin. Secretary : J. E. S. King. Registered office : West Bar Chambers, Boar Lane, Leeds.

Dominion Malleable Ltd. Private company. Registered July 27th. Capital, £20,000 in £1 shares. To carry on the business of ironmasters, steelmakers and converters, smelters, ironfounders, forgemasters, etc. The subscribers are to appoint the first directors. Qualification, 100 shares. Registered office : Etna Works, Rolfe Street, Smethwick.

LIMITED PARTNERSHIPS.

Frank A. Reside & Co. Registered August 5th, by Jordan & Sons Ltd. Machine tool makers and engineers, etc. Longroyde Tool Works, Thornhill Road, Rastrick, Brighouse, Yorks. Partnership for one year from August 2nd, 1920, thereafter terminable subject to six months' notice. General partner : F. A. Reside, 2, Ridge View, Thornhill Road, Rastrick, Brighouse. Limited partner : J. Wright, Bramston Street, Rastrick, Brighouse, contributing £1,000 in cash.

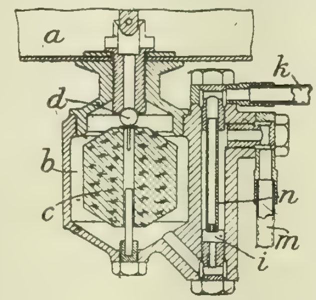
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the lates date possible, and are abstracted from the Illustrated Officia Journal of Patents, which is published weekly.

LUBRICATORS.

131,811.—G. H. ALEXANDER, 83, Coleshill Street, and R. J. NASH, 107, Bristol Road, both in Birmingham.—Dec. 24th, 1918.—Oil is drawn into a crank case of an internal-combustion engine by suction assisted by suction from the induction pipe, so that the supply varies automatically with the load on the engine. Oil

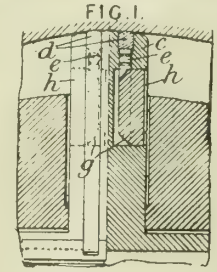


from a reservoir *a* is admitted to a chamber *b* in which a constant level is maintained by a float *c* and valve *d*. From the chamber *b* the oil passes to a chamber *i* and thence through a small orifice into a depending tube *n* connected by a pipe *k* to the crank case. A pipe *m* connects the chamber *i* to the induction pipe.

ROTARY ENGINES, PUMPS, ETC.

132,138.—I. TURNER, Fir Tree House, Rochford, Essex.—Dec. 17th, 1918.—In a rotary engine, pump, etc., the vane *c* is provided with packing-pieces *d* held in contact with the casing by plungers *e*

FIG. I.

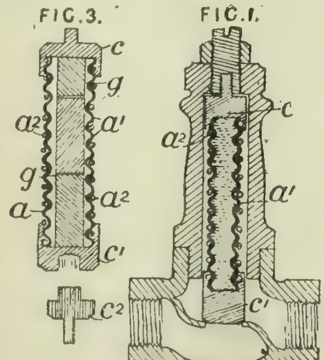


in guide-slots. A plug *h*, the outer surface of which is exposed to the pressure of the working fluid, bears with its conical inner face *g* upon the plungers to hold the packing-pieces against the casing.

THERMOSTATS; STEAM-TRAPS.

132,631.—J. MACKINTOSH, 167, Gilmore Place, Edinburgh.—Sept. 28th, 1918.—An expansion member for a thermostat or steam-trap comprises a spirally corrugated metallic tube *a1* armoured with wire *a2* and retaining the expanding fluid by means of caps *c*, *c1*

FIG. 3. FIG. I.



cast on the ends of the tube. In some cases, additional strength is given by the insertion of struts or stays *g*, Fig. 3. Fig. 1 shows the device fitted in a steam-trap, the cap *c1*, in this instance, acting as the valve. A separate valve *c2* is shown in Fig. 3.

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CONTENTS.

EDITORIAL.

OVERTIME.

The Embargo.

The intolerable attitude adopted by engineering workers in refusing to work overtime under any circumstances not only caused inconvenience to employers, but inflicted considerable hardship on numbers of their fellow-workmen who were held up because of plant breakdowns. A more reasonable view is now being taken, and the suggested agreement drawn up by the Engineering and National Employers' Federation and the Amalgamated Engineering Union should prove satisfactory to both parties. Systematic overtime is never economical, nor for that matter is occasional overtime, unless for the repairing of plant, when greater loss may be involved through machinery being idle.

It was no uncommon thing until recently, in some districts, for workmen to work two nightshifts and one dayshift without sleep. Even if, because of exceptional circumstances and close supervision, work proceeds all the time, reaction sets in afterwards, and this is a natural sequence. Overtime is not good for the workers' health, nor is it profitable for the employer who pays an increased rate for, as a general rule, less effort.

Sometimes Necessary.

The suggested agreement recognises the impossibility of abolishing overtime altogether by limiting systematic overtime to 30 hours in any four weeks. For many districts this is not new. We believe we are right in saying that long before the war some, if not all, of the engineering trades on the Clyde and the North-East Coast had a time limit, but it is the first time that both sides have decided in conference against overtime. It has always been customary, however, to exclude repair work of all kinds. There is a great difficulty, for instance, in ship-repairing centres. It would be manifestly unjust and unwise to keep a ship in the graving dock longer than necessary rather than that overtime should be worked, and the minimum per head is only possible by giving all an equal share. But even with ship-repair work overtime is expensive and bad from every point of view, if work can be got through in the ordinary hours by employing more men. Casual labour for the many, we suggest, with all that can be said against it, is better than overtime for the few.

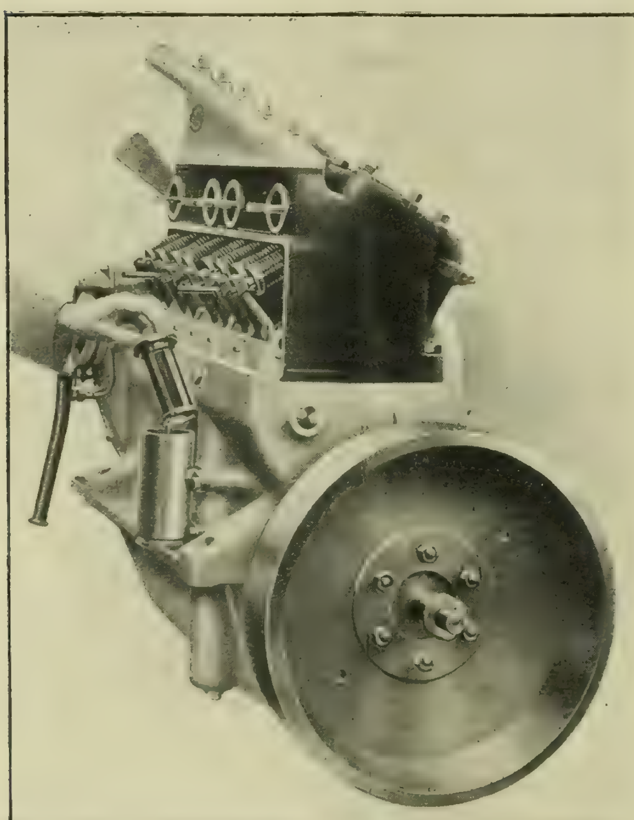
The Minimum in Future.

There has always been a proportion of workers desirous of shorter working hours, not because of the additional opportunities obtained for recreation and self-improvement, but because of the higher rate starting earlier, but they have never been in the majority. The inducement of higher rates has always had to be offered to get men to work overtime. Under the new agreement the overtime rates have been fixed high, too high we believe for employers to pay, on most classes of work. During the war period the overtime question was little short of a scandal in many parts of the country. Conditions were not competitive: there was neither inclination nor was it permissible to cause trouble, and so much of the work that was done at the week-ends or in the night-time at high rates could have been executed in the ordinary hours. Now and in future, however, overtime will only be resorted to because of a labour shortage or to effect necessary alterations or repairs.

NOTES ON THE OLYMPIA COMMERCIAL VEHICLE SHOW.

The last British commercial vehicle show of national magnitude was held in the summer of 1913. The intervening seven years have not only established motor transport beyond the cavil of the most sceptical, but they have had their influence on mechanical developments, though this is not as extensive as might be expected. Indeed, the small amount of radical modification is a wonderful tribute to the soundness of the basic lines of design in vehicles, which, though built for the good British roads, could yet show themselves so effective over the appalling surfaces of the war front.

The Ricardo-Tylor engine on one of the A.E.C. chassis is an example of war development. This is



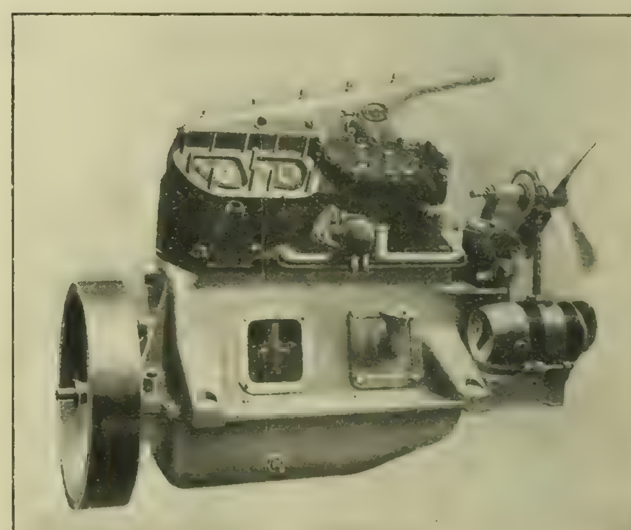
The Guy Engine Design.

designed with crosshead pistons working in air-cooled trunk guides, over which the air supply to the carburetter is drawn to warm it. There can be no question about the value of this form of piston for almost eliminating cylinder wear and getting over difficulties of cylinder lubrication and carbonisation. The engine is designed with T cylinder heads, as less inefficient than the side-by-side valve arrangement, and this disposition, involving separate camshafts on each side, enables the engine (thanks to the tappet design) to be run as a right or left-hand engine without any need for changing over the camshafts.

On the whole, engines and transmissions show little radical change, and petrol engine design gives the impression of not being so advanced as in the private car. This is partly due to the more limited requirements of the heavy vehicle. The final drive reduction is fully double that of the private conveyance, and the far more limited range of speed hardly calls for the same degree of refinement, especially in the matter of flexibility. What is generally wanted is a substantial, hard-wearing engine reaching the top of its torque curve at about 1,000 to 1,200 revolutions per minute and capable of maintaining a steady pull at the lower speeds.

Yet in such matters as facilities for cylinder cleaning, too, the business car engine is, on the whole, behind the pleasure car, and seeing the importance of avoiding laying off the machine any more than necessary, this is a point that might well receive more attention.

Is the six-cylinder lorry coming? At Glasgow last winter a six-cylinder Halley char-a-banc was exhibited, and now the first six-cylinder lorry is on view. Maintenance is every month becoming a



Guy Engine.

more important cost item, and the smoother torque effort of the six-cylinder arrangement might do much to counter-balance the extra cost which, given the manufacturing plant, need not amount to much extra. Six cylinders do not cost so very much more than four, and, as to compactness, the six cylinders on the Halley lorry are so compactly arranged that they only require three inches more than the normal four-cylinder engine proper to a chassis of the same size.

On the whole, engine arrangement follows standardised lines, but in this respect the Guy offers an interesting study with its rocker-worked valves arranged at an angle of about 45 deg. to avoid pockets, and its cylinder head detachable.

The Guy 2-ton lorry, by the by, affords the only instance of a vehicle governed by road instead of engine speed, for the governor is mounted in the front joint casing of the propeller shaft.

The arrangement by which the engine and separate gearbox on this chassis is mounted on a single

sub-frame suspended from the main frame and made easily detachable, is also worth attention. The more general plan, of course, is to include engine and gearbox in the same casting arrangement, which also forms the well for the clutch, the whole being three-point supported to avoid frame distortion stresses.

Up till comparatively recently it was found that this three-point support was only suited to engines of smaller sizes, but now it is being adopted for larger and larger engines, and its use is greatly on the increase even on some of the larger cars, particularly the Americans.

On big chassis there appears a slightly increasing tendency to thermo-syphon cylinder cooling, but in all cases a fan is used in conjunction with the radiator.

With a single exception, engine lubrication follows one of two general systems. In both cases oil is forced to the main bearings by pump, but in one it is maintained at constant level under the big ends in troughs, whence it is scooped to the crank pin bearings; in the other, it is forced to the big ends through passages drilled in the crankshaft. In either case the oil after use passes to the filter, and is circulated for further use. The only exception is in the Albion, which only uses the oil once, and delivers it fresh and separately to each working part —main bearings, big ends, cylinders, distributions gear, and governor.

The number of engines fitted with starting and lighting equipment can hardly escape notice. It has taken a long time for the commercial vehicle industry to take to these, but motor spirit prices are working in their favour. For the most part they are fitted on passenger carriers, but several lorries are equipped with them, and the engine starter at any rate is just as necessary on a big goods carrying vehicle.

In transmissions, commercial cars have an introduction in a Thomas gearbox, which is worth attention on account of its extreme compactness, and the fact that all engagement is effected by dog clutches. and the driving stress cannot be transmitted to the gears until they are in mesh. Some of these points are not new, but to those who have not made a special study of road vehicles they are worth pointing out.

The most prevailing impression is given by the number of heavy vehicles mounted on pneumatic tyres. For at least fourteen years, attempts have been continually made to run heavy 'buses and such like cars on air-filled tyres. Yet success has never been approached until a few years ago, the Americans, and notably the Goodyear Tyre Co., took the problem in hand. This resulted in a frank recognition that hitherto existent forms of pneumatic tyre, as used on private cars, were not suited to the severe stresses imposed by the bigger vehicles, and consequently in these giant pneumatics the conventional rounded side has given place to a straight-sided construction, and the beaded edge has been definitely abandoned in favour of a wired-on construction. Now that detachable rim flanges have become commonplace, there is no longer any reason for the retention of the beaded edge, and even on lighter vehicles, like the private car, it will disappear.

As yet it is early days to form a definite opinion on these giant pneumatics. The big vehicles on which they are mounted are purely for business purposes, and therefore it is simply a matter of £. s. d. direct or indirect. Whether they become so general as to involve relatively cheap production remains to be seen. At present they are rather in the tentative stage, and the cost is certainly heavy—fully three times as much as solids—but it is claimed that owing to the straight-sided construction they can give far greater mileage than the ordinary pneumatic. The writer knows of at least one case of a set of char-a-banc tyres running over 9,000 miles with little apparent wear, which points to a mileage equal to the generality of solids. In some instances, too, they have shown a quite surprising saving in petrol. Also, they are certainly easier on the mechanism. and so on the maintenance bill.

Yet it is questionable whether, in their very largest sizes, these big tyres will be as successful in damping vibration as the more moderate sizes. The biggest have to be pumped up to about 130 lb. per square inch, and for this reason for the back wheels the ultimate solution may be found in more moderate-sectioned twin tyres requiring only 80 lb. to 100 lb. pressures, despite the disadvantage of "twins" on highly cambered roads, for this trouble can be compromised by inflating the inner tyres rather less than the outer; besides, the road authorities now recognise the undesirabilty of extreme camber, and are gradually modifying their roads accordingly. Nevertheless, it is worth mention that the London Police Authorities for licensing purposes have just decided to turn down the giant pneumatic tyre.

Another development with the same object is afforded by the cantilever springing of the Palladium chassis. I have tried this, and it certainly gives such beautifully easy riding at the back that more is likely to be seen of it.

In the body-building section, Morgan & Co. are showing a striking char-a-banc body involving a form of construction new to the business passenger vehicle, though it has been extensively in use on pneumatic tyred private cars. The frame is made of weldless steel tubing, and each rectangle of the framing is braced by cross diagonal straining wires as in aeroplane construction. These have no turnbuckles, but as the knuckle joints holding them to their lugs are screwed right and left-hand thread, it is claimed that they can be tightened, as all upholstery is immediately detachable and they can easily be reached. No welding or brazing is required; all framing joints are mechanical, and a variety of these are available, according to the stresses to be met. The aluminium panelling is secured to the framing by rivets. As all doors are on the rear side, so while on that side the underframing only has the usual one runner, on the other side, which is weakened by the door openings, an additional runner is employed. These runners are made of light inverted ∩ section steel, drilled out for lightness and braced by tubular cross bars, and diagonal wire stays. The floor is a pressed-steel and built-up construction carrying aluminium floor plates with felt interposed below them, and everything is so light that the whole body, with hood, upholstery, running boards, screen, and wings, only weighs 12 cwt., as compared with about a ton

for the ordinary body. It is an engineering job throughout, without a scrap of wood, and in addition to lightness, as the construction lends itself to quantity production, a very big saving in cost is claimed.

In steam wagon design there is rather an absence of anything startlingly new, but that is not altogether surprising, seeing the comparatively small numbers involved, and the fact that the steam engine has reached a relatively established stage of development. The most striking departure is unquestionably the uniflow type of engine employed on the Atkinson wagon. The wagon in itself is comparatively recent; in fact, it was the only new design to make its appearance during the war. This accounts for the fact that it has been designed exclusively for work on rubber tyres. For steam wagons the iron or steel tyre has become so much a thing of the past that not a single such vehicle in the show is mounted on them; indeed, the appearance of a machine so equipped would cause surprise. The same, of course, does not apply to the steam tractors, yet even some of these machines on view are carried on rubber tyres, in spite of their huge back wheels; some have rubber tyres as big as 1540 by 140 mm.

At the present time steam wagons may broadly be classified either as overtype, with the engine on top of the boiler on the lines of the old tractions, or as undertype, with the engine separate from the boiler and placed beneath the chassis framing. There are in the country only two manufactured designs that do not come under one or other of these classes, and, of these, only one, namely, the Yorkshire wagon with its double-ended loco. boiler, was to be seen at Olympia. The other is the National, a most interesting coke-burning machine designed on petrol vehicle lines, and it is a great pity that it is not in evidence at this exhibition.

Except in the case of the undertype wagons with big slow-speed undertype engines driving by chain direct to a live back axle, and with a large margin of power, steam wagons have very generally been given two speeds, but of late years there has been a marked trend towards increasing to three, and good examples of one, two and three speed machines are all available.

For a number of years past Clayton & Shuttleworths have been turning out steam wagons, but now this branch of the activity has been taken over by a daughter firm, Clayton Wagons Ltd., that is setting up in business for itself. At Olympia it is represented by an example of the overtype design familiarised by Clayton & Ssuttleworth, but the new undertaking has also embarked on the construction of an undertype vehicle, one of which is also displayed. This has a vertical water-tube boiler and an enclosed engine, with the long piston slide valves worked by single eccentrics mounted on a separate layshaft spur gear driven off the crankshaft, and variation in cut off and reverse is effected by sliding the layshaft to one side or the other. Unlike the generality of these slow-speed engines driving direct to the back axle, the engine can be run free by disengaging a double eccentric clutch.

On the loco. type, steamer piston valves are now used on both cylinders; formerly a flat D was employed on the low-pressure side, but the most notable characteristic in this vehicle is in the use of a small steam turbine, geared down so as to drive the double screw gear for tipping the body.

Based as it is on traction engine design, the over or loco. type wagon has been but little subject to change until about a year and a half ago, when Robey's, of Lincoln, brought out their new design. In this, the most striking departure lay in the boiler, which, for the sake of lightness and cheapness, was constructed with an internal firebox that may best be described as forming truncated cone with a domed top, and the outer shell, where it projects below the barrel is similarly circular, while at the back it follows the curve of the firebox roof, and so gives the rear end of the boiler a half-dome shape. Such a construction dispenses with any need for roof or firebox stays, and it has recommended itself sufficiently to induce a firm like Ransomes, Sims & Jefferies to follow suit. The wagon on these lines, which they are exhibiting at Olympia, is the first vehicle of this sort coming from their works, though for many years past the firm have been making steam traction designed to come within the weight limit of the Heavy Motor Car Order.

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By Eric M. Bergstrom, of London.

Associate Member of the Institution of Mechanical Engineers.

(Continued from page 7, October 8.)

Medium-Pressure Francis Turbines.

The leading features of this type of installation are that the turbines are totally enclosed either in a cylindrical or spiral casing, the former generally adopted for medium and the latter for high pressure, although the spiral casing, in spite of increased manufacturing cost, is now commonly adopted also for medium-pressure plants. As a rule, horizontal-shaft turbines are employed, but also in this case American engineers have lately shown a marked preference for vertical-shaft turbines for medium heads, enclosed in spiral casings.

A typical medium-pressure installation with horizontal shaft is the Trollhättan Hydro-Electric Power

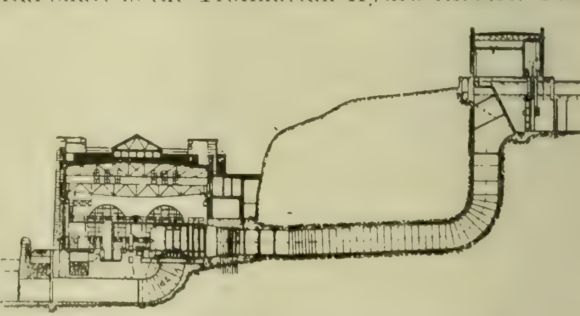


Fig. 19.—Section through Power Station and Intake Building, Trollhättan. Diam. of penstock 13 ft. 6in.

Station, Sweden, of which Fig. 19 shows a section of the power-house. The fall available is 106 feet, and eight units each having a maximum output of 12,500 H.P. at 187·5 revolutions are installed. Each unit consists of a double Francis turbine enclosed in casing of riveted steel-plate; the water enters the

casing axially direct from the penstock, and is gradually diverted to all sides of the turbine by the conical end-shield forming part of the inner inspection chamber. The regulating gears for the guide-apparatus are also situated outside, accessible at any time for lubrication and inspection. This feature of turbine design eliminating under-water bearings and regulating gear is, of course, of great value for large plants in continuous operation for long periods, where interruption of service necessary for inspection of bearings or other parts situated under water cannot be permitted. In addition, the guide-apparatus has in this case been designed in such a manner enabling each separate guide-vane to be renewed without dismantling any other part of the turbine, with a view to reducing to a minimum any interruption of service necessary to effect repairs.

Although the horizontal arrangement of medium-pressure plants has been adopted in a large number of installations in America, recent designs have, as already stated, again displayed the preference for vertical arrangement entertained in that country and the tendency of using this construction wherever local conditions permit. A typical instance of this construction is shown in Fig 20, representing a section through a unit at the Gatun Lock Hydro-Electric Power Station, Panama Canal. This station is at present equipped with three units with an output of 3,600 B.H.P. each when operating under an effective head of 75 feet at a normal speed of 250 revolutions per minute. The turbines are set vertically in a cast-iron spiral casing connected to the penstock. The runner is cast solid in bronze, and designed to eliminate water pressure on the top, so that an upward thrust is exerted, relieving the thrust-bearing of one-third of the static load. The generator is placed direct on a cast-iron distance ring 7ft. 6 in. high, connected to the spiral casing, through which the whole weight of the unit is transmitted to the foundations. The foundation-ring also carries the oil-pressure governor driven from the vertical shaft by means of bevel-wheels. The roller thrust-bearing is placed on the top of the generator, in addition to which there are two auto-

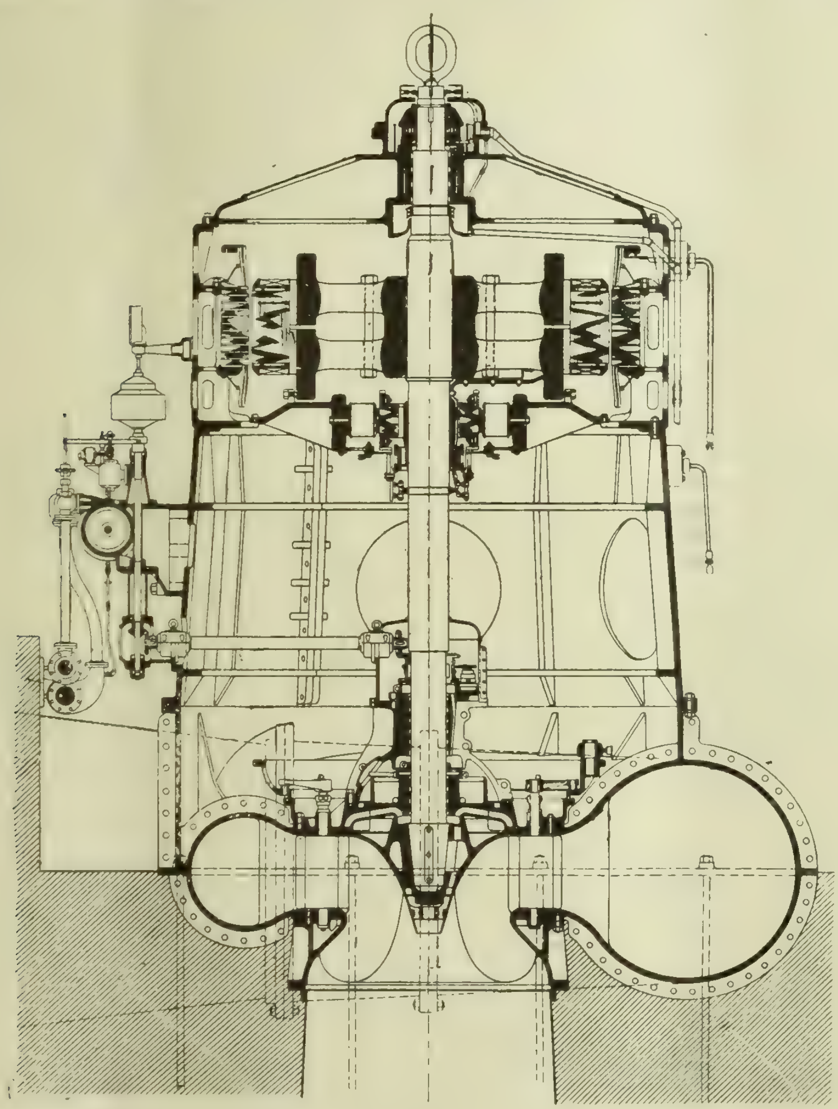


Fig 20.

matic oil-lubricated guide-bearings, one immediately below the thrust-bearing and one at the turbine end of the shaft.

Identical design and construction has been adopted for a large number of plants, notably the plant for the Tallassee Power Co., which turbines are designed for the largest output installed up to the present moment, each turbine having an output of 31,000 H.P., with a speed of 154 revolutions per minute under a net head of 180 ft. and a guaranteed efficiency of 90 per cent.

The Hydro-Electric Power Commission of Ontario contemplates the installing of four vertical single-runner turbines at the Chippawa-Queenston plant, having an output of 52,500 B.H.P. per unit of 187·5 revolutions per minute under an effective head of 305 feet.

The vertical arrangement of medium-pressure turbines has been more seldom employed in Europe, having only been adopted where its use has been warranted on account of local conditions in preference to the horizontal construction as, for instance, at the Seros Power Station of the Barcelona Light and Railway Co., Spain.

A unique installation of the medium-pressure type turbine is the Porjus Power Station, Sweden. As in the case of the Mockfjaerden Power Station, this plant is also situated underground, but the turbines are enclosed in steel casings and placed at the bottom of the intake shafts about 160 ft. below ground level. The vertical shafts are cut through solid rock and provided with liners of steel pipes with an internal diameter of 11 ft. 6 in. and with flanged connection to the turbine-casing. There are five units with an average capacity of 12,500 H.P., each under a net fall of 163 ft., running at 225 revolutions per minute. The turbines are of the double type with two runners, discharging into the common suction-casing. The power-house is also blasted out of solid rock, and is 36 ft. wide and 310 ft. long, communicating with the turbine chambers through the short tunnels which accommodate the shaft extension connecting turbines and alternators.

The roof is supported on a strong concrete arch, and by provision of false walls and roof leaving a space between the rock and the walls, through which warm exhaust air from the generator is allowed to pass, all damp is prevented from penetrating into the power-house. The generators have a normal output of 11,000 kva. and 10,000 to 11,000 volts 3-phase current. The necessary switchgear and transformers are also in this case placed in a separate building on ground level, a shaft providing communication between this building and the power-house below, through which the heavy parts of the machinery can be lowered, in addition to which there is lift accommodation both for passengers and goods. The line voltage is 80,000, the power being utilised for railway traction and for mining purposes.

Finally, as an instructive example of the arrangement of the medium-pressure turbine with horizontal shaft and spiral casing, Fig. 21 shows a section through a unit of Massaboden Hydro-Electric plant used in connection with the Simplon Tunnel in Switzerland. Each unit is capable of developing 3,500 B.H.P. under a net head of 142 ft. at 500 revolutions per minute. The turbine is equipped with two runners cast back to back in one piece, the outside bearing being arranged with thrust-collars to take up any unbalanced thrust in axial direction.

In concluding this brief reference to medium-pressure plants it is a noteworthy fact that, as in the case of low-pressure turbines, recent developments, at any rate in America, seem to favour the single runner units, on account of the higher mechanical overall efficiency obtained, and less foundation work coupled with lower initial cost, although each individual case has to be decided on its own merits and considered in conjunction with other factors depending on local conditions. It is, however, interesting to quote as an instance, that the Stave Falls Hydro-Electric Plant, owned by the Western Canadian Power Company, in 1909 installed four horizontal double turbines, each of 13,000 H.P. under a net fall of 110 ft. enclosed in casing, similarly arranged as the Trollhättan plant just described. The General Manager of the Company in a paper read before the Canadian

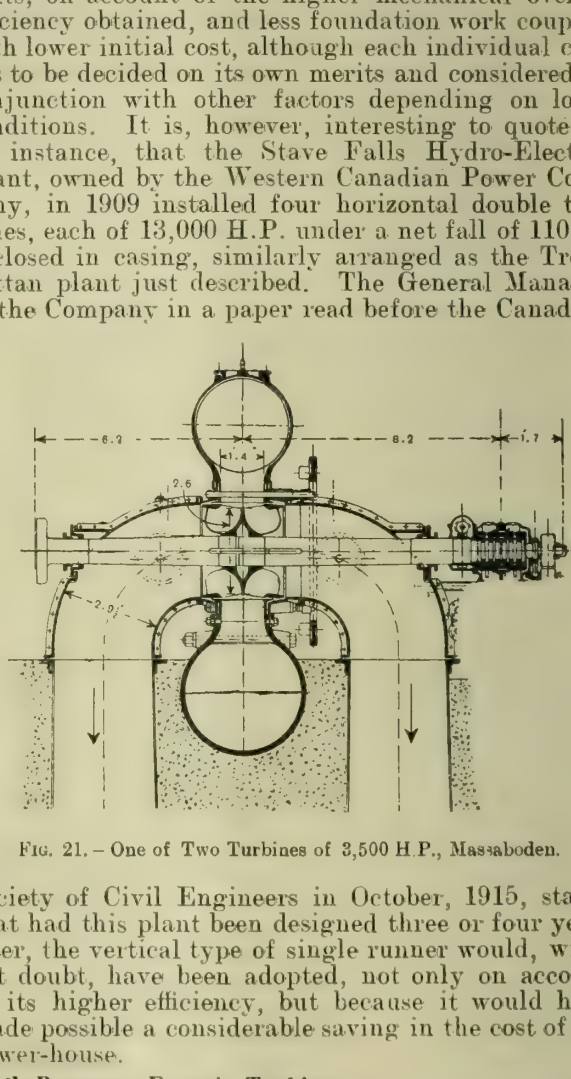


Fig. 21.—One of Two Turbines of 3,500 H.P., Massaboden.

Society of Civil Engineers in October, 1915, stated that had this plant been designed three or four years later, the vertical type of single runner would, without doubt, have been adopted, not only on account of its higher efficiency, but because it would have made possible a considerable saving in the cost of the power-house.

High-Pressure Francis Turbines.

Much attention has of late been focussed on the development of low and medium Francis turbines, but nevertheless the high-pressure Francis turbine has shared in the remarkable and rapid development and improvement in design of the hydraulic turbine. The most notable feature of the progress in the case of the high-pressure turbine is its adoption for a very much higher head than ever contemplated until a few years ago, and this has considerably increased the field for the employment of the Francis turbine, in fact, under certain conditions, it even rivals the Pelton Wheel which, until recently, was the only accepted type of turbine to be adopted for high heads.

Whereas only ten years ago Francis turbines working under 300 ft. to 400 ft. head were indeed considered high-pressure turbines, to-day Francis turbines utilising a head of from 500 ft. to 600 ft. are

not uncommon, the highest fall of which a Francis turbine has been designed being approximately 745 ft.* The reason for the development of the Francis turbine for high pressures is again due to the modern tendency of larger capacity per unit coupled with maximum permissible speed to reduce the cost of the electric generators. This fact is easily appreciated if reference is again made to the conditions of the specific speed which is the governing factor for the type of turbine to be employed.

As already stated, the lowest limit for employment of a Francis turbine with a commercial efficiency corresponds to a specific speed of approximately 11 (49). On the other hand, the maximum specific speed for a single-jet Pelton Wheel is approximately 5 (23) which reveals the existence of a "missing link" corresponding to a specific speed of from 5 to 11 (23-49) under which conditions neither a Francis turbine nor a single-jet impulse wheel can be efficiently employed. For a given set of conditions corresponding to a specific speed within these limits, it has been necessary to use Pelton wheels with two or more jets, or two single-jet Pelton wheels, one on each end of the generator shaft. The present tendency, however, of increasing the capacity together with a higher actual speed, would correspondingly increase the specific speed and bring it within the limits of the Francis turbine where previously Pelton wheels only would be used. This fact, in addition to the introduction of high-speed generators also for large capacities due to the development of the steam turbine, have equally contributed to this important extension of the field for employing Francis turbines.

As a result, the design of the Francis turbine has been modified and improved to answer the additional requirements of water turbines working under high pressure, and, as already stated, has now been employed under heads of approximately 745 ft. In its early stage, this new departure in the design of Francis turbines was not free from adverse criticism, as it was feared that owing to the high velocities of the water when passing through the runner, excessive wear and erosion would not only reduce the efficiency of the turbine in a short time, but also increase the cost of maintenance as compared with high-pressure impulse-wheels. The improved design, securing proper acceleration of the water through the turbine and eliminating the formation of eddies, together with careful selection of the material for the runners have, however, enabled the high-pressure turbine to answer the requirements fully and successfully to stand the severe test to which it has been subjected, and there exists no reason why this type of turbine, where the conditions permit, should not be employed up to a head of approximately 1,000 ft.

One of the earliest high-pressure plants was the turbine installed by the California Gas and Electric Corporation, of which a section is shown in Fig. 22, and which has been in service since 1907 with most successful results. The plant consists of a single-runner turbine in spiral casing with a capacity of 9,700 H.P. under a net head of 512 ft. and a speed of 400 revolutions per minute, thus corresponding to a specific speed of 14·75 (65·5). Without exception the high-pressure turbine is designed with horizontal shaft for direct connection to generator, and provided with single or double runner enclosed in spiral casing. The guide-vanes are forged solid with a single spindle passing through metal-lined packing-boxes, and externally connected to the regulating ring by means of links and levers.

* E. H. da Serra de Estrella, Spain.

The selection of the most suitable material for the runner to withstand corrosion or pitting due to chemical reaction was a factor of great concern in the early development of high-pressure turbines, but recent investigations have established the now generally accepted theory, that the primary cause of pitting is due to faulty design of the runner resulting in the formation of eddies, from which free oxygen is dissociated on account of the high velocity of the water at these points. Corrosion can therefore be entirely eliminated by correct design of the water passages and the selection of the runner material from this point of view is of less importance. On the other hand, the erosive action caused by sand or other foreign matters carried in the water is more difficult to guard against, and where the conditions of the water are such so as to make

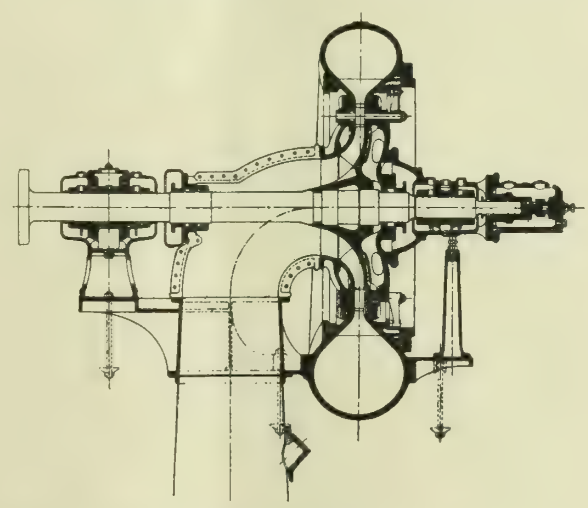


Fig. 22.—Turbine for California Gas and Electric Corporation. Scale about $\frac{1}{64}$th.

it liable to produce erosion, the turbine inside the casing is fitted with renewable liners of cast steel, which material, owing to its hard surface skin, probably offers better resistance against erosion than any other material. The runner is also in such cases made of cast-steel, but for the smaller diameter runners with narrow inlets phosphor-bronze is used to obtain a cleaner casting. Where sand, however, is carried in any appreciable quantity suitable arrangements are made at the intake so that the sand can settle and not be carried into the turbine. Where the water is comparatively free from grit cast-iron runners are now used to a great extent, even under the highest head, as on account of its smoother surface, as compared with cast steel, it is less susceptible to pitting, and only when the peripheral speed does not permit its use is steel cast resorted to.

(To be continued.)

EVOLUTION OF THE ELECTRIC BRASS FURNACE.

By H. M. St. John.

An electric furnace classification is based, as a rule, on the difference of method utilised for the application of heat to the material under treatment. In this case the species are three:—

The induction or direct resistance furnace, in which heat is generated in the metal itself by virtue of its own resistance to the passage of an electric current.

The arc furnace, in which heat is generated between an electrode and the metal, or between independent electrodes, and transferred to the metal by conduction or radiation, direct or indirect.

The indirect resistance furnace, in which heat is transferred from an incandescent resister to the metal by conduction or radiation, somewhat as in the arc furnace.

All of the electric furnaces so far proposed for melting brass naturally fall in one of these classes, or a combination of some two of them.

In the beginning the would-be inventor of an electric brass-melting furnace was obsessed by the idea that such a furnace should bear a close resemblance to the combustion furnaces then in use for that purpose. In the electric crucible furnace, as in the fuel-fired crucible furnace, the heat must, in general, be generated at some point outside the crucible and transmitted to the metal through its walls. A favourite suggestion was to surround the crucible with an electric resister of granular nature, which was heated to incandescence by the passage through it of a suitable electric current.

Most of these fundamental difficulties were obviated by using a resister which surrounded the crucible but did not come in contact with it. In this way the heat generated in the resister was first transmitted to the crucible by radiation, and, finally, by conduction through the walls of the crucible to the metal.

To the writer's knowledge, the only furnace of this type which was ever operated with any degree of technical success was equipped with wall resisters of thin carbon slabs, provided with means of variably adjusting the contact pressure between the slabs. The generation of heat in this furnace depended, not on the resistance of the carbon itself, but in the contact resistance between the slabs, which could be varied at will in such a way as to provide an excellent means of controlling the current and voltage, and thus the rate of power input. Despite its good qualities, it was soon apparent that this furnace could never be commercially successful. Its maintenance cost, both for carbon electrical parts and refractories, was a serious handicap, but more serious still was the fact that its thermal efficiency was inherently and irremediably low.

The latest proposal to melt brass in an electric crucible is one which has recently been very thoroughly described and discussed, in which the metal within the crucible is heated by a high-tension, high-frequency induction or eddy current. The walls of the crucible itself are electrically conducting and serve to heat its contents during the period while the metal is still solid, and in pieces not in good electrical contact with each other. Most of the disadvantages already described as characteristic of the crucible furnace have been overcome in this design. This new type has, however, so far been built in sizes more suitable for the laboratory than the foundry.

The low thermal efficiency of crucible furnaces heated from without naturally suggested the possibility of utilising the walls of the crucible itself as a resister. This principle was tried out quite thoroughly rather early in the development of electric furnaces for melting brass. In one type the crucible was built of a special mixture with suitable electrical conductivity, but no attempt was made to insulate the walls of the crucible from the metal which it contained. In another design this feature was taken care of by means of special insulating lining separating the conducting walls from the metal. It proved almost impossible, however, to maintain this insulating layer, and short circuits invariably resulted.

Overhead Resister Furnaces.

Not all, even of the early experimenters, limited their attention to the crucible furnace. The advantages of a larger furnace capacity and the elimination of crucibles were sufficiently obvious, and had already resulted in a considerable use of various types of direct-flame oil and gas furnaces. The earliest attempts to melt brass electrically in a furnace of this sort made use of an incandescent resister supported above the bath and radiating heat directly to the metal. This construction, applied to an open-hearth furnace of small capacity, gave rapid melting and a fairly high thermal efficiency. The principal difficulties were two; the development of a resister which would stand up continuously under the required conditions without an excessive maintenance cost, and the invention of some reliable method for supporting the resister in the desired position over the bath. Neither of these basic problems has ever been adequately solved.

The difficulties which interfere with the use of an overhead resister are partially avoided if the resister is located above the bath, but at either side or surrounding the central portion of the melting chamber.

One well-known type of furnace now in commercial use employs this principle, utilising for the purpose a granular resister contained in a nearly circular refractory trough. This trough is exposed to very severe usage, since the resister temperature must be much above that of the molten metal. The roof also is at a temperature considerably in excess of that of the metal, and must be highly refractory. Another type of furnace which is in somewhat limited commercial use employs a combination of granular resister and smothered arcs at either end of the melting chamber. In this type also most of the heat must first be radiated to the roof and then to the metal.

A high thermal efficiency was early recognised by investigators in this field as an absolutely essential qualification for the permanently successful electric brass-melting furnace. It seemed obvious that if some practical method could be devised for generating heat in the metal itself, conditions most favour-

able for a high-efficiency would be produced. The celebrated pinch-effect phenomenon is too well known, and has been too often discussed to require definition here. The pinch-effect can be utilised to increase substantially the electrical resistance of molten brass through which a heavy electric current is flowing. This was done with considerable success in designing the first practical direct-resistance furnace for brass. It has recently been proposed to change the construction of this furnace in such a way as to eliminate the massive metallic electrodes.

The elimination of electrodes from the design of the direct-resistance furnace was evidently of the highest importance. This was done in a somewhat later type of furnace by constructing it as a vertical-ring induction furnace with the resister channels jointed at the bottom to form a complete circuit for the passage of electric current. The limitations of the vertical-ring induction furnace are due, first of all, to the fact that it is an induction furnace, and as such, cannot be constructed in large sizes without introducing electrical disadvantages such as low power factor.

Furnaces of the Arc Type.

The widespread success of the arc furnaces in the melting of steel was not overlooked by those more particularly interested in the brass industry. Many attempts were made to apply both direct and indirect arc furnaces directly to the melting of brass, without changing the design which had been found most suitable for steel melting. These attempts were pretty uniformly unsuccessful, because copper and its alloys—particlarly the high-zinc alloys—suffered under the direct application of such a high temperature heat source as the electric arc.

A great deal of study was devoted to the discovery of some method which would make possible the utilisation of the good features of the electric arc for brass melting. The direct type of arc furnace was evidently out of the question. In the indirect arc furnace, overheating was less localised. It seemed probable that if the metal could be stirred with sufficient vigour, the entire bath could be maintained at a uniform temperature, and tendency toward local overheating could be entirely neutralised. It was found by experiment that rocking the furnace mechanically at the rate of approximately two oscillations per minute, resulted in a degree of agitation ample to maintain complete uniformity of temperature throughout the molten bath, and that the obvious advantages of the arc furnace could be utilised in this way without the slightest injury to the metal, even in the case of alloys containing 40 per cent or more of zinc.

The so-called rocking electric furnace resulted from this development and is in wide commercial use at the present time for melting all classes of copper alloys, as well as copper itself. As in the induction furnace, the vigorous stirring of the metal results in a uniformity of temperature and of composition throughout the alloy, a feature which is of particlar importance in the melting of high lead alloys.

The pronounced success of the rocking type of arc furnace has prompted many suggestions for modified designs, similar to it in principle, but differing from it in details of construction. For example, it has been proposed to rotate the furnace body instead of merely oscillating it.

This brings us to a brief consideration of what the brass-foundryman can expect, and ought to realise from the use of electric furnaces.

The first, and probably the most important point, is the saving of metal—commonly wasted during the melting process—which electric melting makes possible. If the charge to be melted consists of new metal or clean scrap, the net metallic loss during melting and pouring from the furnace should not exceed 1 per cent for yellow brass, and 0·5 per cent with red brass. With clean yellow brass, containing 40 per cent of zinc, losses as low as 0·75 per cent to 0·85 per cent have been experienced as an average for a considerable tonnage of metal melted. In melting a scrap charge containing a high percentage of non-metallic, such as oily borings, chips, grindings, etc., the net loss should not exceed 2 per cent.

It is also true that the furnace which melts without agitation is not particularly well suited for melting a charge which contains a high percentage of finely divided, dirty scrap, while these can be handled without difficulty in either induction or rocking arc furnaces. Brass melted in the electric furnace is practically free from metallic-oxide drosses and has no opportunity to pick up sulphur or other contamination from combustion gases.

The consumption of electricity energy under average condition of 8-hour to 10-hour operation is as low as 240 kw.-hours per net ton for yellow brass, and 275 kw.-hours per ton for red brass, in the induction or arc furnaces. In the 24-hour operation figures as low as 200 kw.-hours per ton or less have been obtained. Less efficient furnace types use from 400 kw.-hours to 500 kw.-hours per ton, depending upon conditions.

Flexibility, which in this case may be defined as the suitability of a furnace for radical changes in operating conditions, or for an abrupt change in the composition of the alloy to be melted, is a marked characteristic of the resistance and rocking arc furnaces, which is notably lacking in the induction furnace.

The net melting cost, considering all factors which should properly be considered under this head, is naturally lower in those furnace types which melt the metal most rapidly and efficiently, since their use of electric energy is more economical, and their higher rate of production reduces the fixed charges per ton of metal melted. In many cases the cost of electric melting is not more than half the cost of melting the same alloy in combustion furnaces. Even in the less efficient furnace type, electric melting is usually less costly than the older methods.—*Canadian Foundryman*.

Announcement is made that the United States High-Speed Steel and Tool Corporation's new plant at Albany, N.Y., is now in operation. It is stated that after four years of experimental work the company is now manufacturing in quantity high-speed steel tools by casting under its new process. This process of casting steel tools instead of forging, it is claimed, will revolutionise the tool industry in this country, due to its lower manufacturing cost, which is stated as approximately 70 per cent under the highest quality of forged steel tools. It is stated that the company now has orders on its books from many leading industrial corporations.

THE MECHANICAL ENGINEERING INDUSTRY IN GERMANY.

At the annual meeting of the Union of German Mechanical Engineering Works (Verein Deutscher Machinenbauanstalten), held in Berlin recently, Generaldirektor Becker, of Köln-Kalk, said that a year ago orders from abroad were received in such numbers that the German engineering industry after a long period of slackness was able once more to provide its establishments with sufficient work.

During the execution of the orders, however, great difficulties arose owing to the extraordinary rise in the cost of production, brought about by the increased cost of raw materials, the higher wages and greater general expenses, while the value of the mark continued to fall steadily. Many works found themselves in a serious situation from which they could only partly escape by coming to agreements with their foreign customers. Many, moreover, were obliged to agree to the cancellation of foreign orders.

Meanwhile the fall in prices has prevented the German industry from resuming competition with foreign industries, while wages have again had to be increased owing to the higher cost of living. The result is that foreign purchasers of German machines are still holding back and that the former extensive sale territories are quite cut off for the time being. In the neutral countries buyers have fully covered their requirements during and since the war. East and South-East Europe scarcely count as purchasing countries owing to the unsettled political conditions. Italy, France and Belgium are able to meet their own requirements, their engineering industries having developed greatly during the war. As for Great Britain and America, there can hardly be any question of supplying them with machines, for they are both competing with great success in the world's markets, where they have acquired great influence through financial investments.

If Germany is to regain her foreign markets, continued Herr Becker, there must be a reduction in the price of raw materials, the constant rises in wages must be avoided and the working capacity of the shops, which has now sunk so low, must be increased. Moreover, the immediate abolition of export duties must be demanded.

Since March, when the value of the mark began to rise, the number of foreign orders received has considerably declined, and in some cases has completely ceased, while home business is quite at a standstill. These circumstances have led to important reductions in working hours, to dismissals of employees and to the closing down of some concerns. If unemployment has not yet become manifest to any very great extent, it is owing to the fact that a great number of works have been engaged on long-dated orders received before the crisis and that other establishments have avoided reducing their staffs by building machines for stock. To-day enormous stocks of machines worth many millions of marks have accumulated, without hope of any considerable sales. In these circumstances manufacturers must be prepared for great losses, for the banks are no longer inclined to provide financial means for keeping works going on such a basis. There is thus danger in the near future of a great increase in the number of dismissals and further closing down of works.

Herr Becker considers that, in view of the fact that a further rise in the cost of raw materials and a fresh fall in the value of the mark are to be feared, the conclusion of foreign contracts in future will only be possible by the establishment of a sliding scale of prices, but admits that this system will mean yet another hindrance to German export business.

The reasons for the bad state of the home market are ascribed by Herr Becker to the fact that during the war many industries increased their establishments, and are no longer in a position to find a sufficient amount of work for them. Whole works have consequently been closed down and the machinery has been sold abroad. There are many obstacles to any increase in the plants of the various industries, and Herr Becker considers that it is erroneous to think that the holding back on the part of purchasers is due to a kind of "buyers' strike" The truth is much more likely to be that many are not in a position to make outlays even for urgent requirements.

In conclusion, Herr Becker said that the German engineering industry must endeavour to avoid the great waste of labour involved in the extraordinary variety of working schedules in most works and in the diversity of types manufactured. To this end greater co-operation within the industry will be needed, leading in some cases to amalgamation of interests.

It will also be necessary to standardise parts of which great numbers are required. This has been done successfully by the machine tool section, and it is hoped that the example will be followed by other branches of the engineering industry. Reuter.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 11, September 8th and 22nd.*)

The Cambridge Optical Pyrometer.

A modified type of Wauner Pyrometer has been designed by the Cambridge Scientific Instrument Co., and is now in extensive use. The direct-vision prism employed in the original spectrophotometer is dispensed with and a disc of red glass is substituted, so as to give approximately monochromatic light. The selection of the right kind of coloured glass is of importance, and glass makers have given special attention to the production of red glasses suitable for pyrometry.

The general arrangement of the Cambridge outfit is shown in Fig. 14, in which A is the pyrometer mounted on an adjustable tripod E. Within the teak carrying

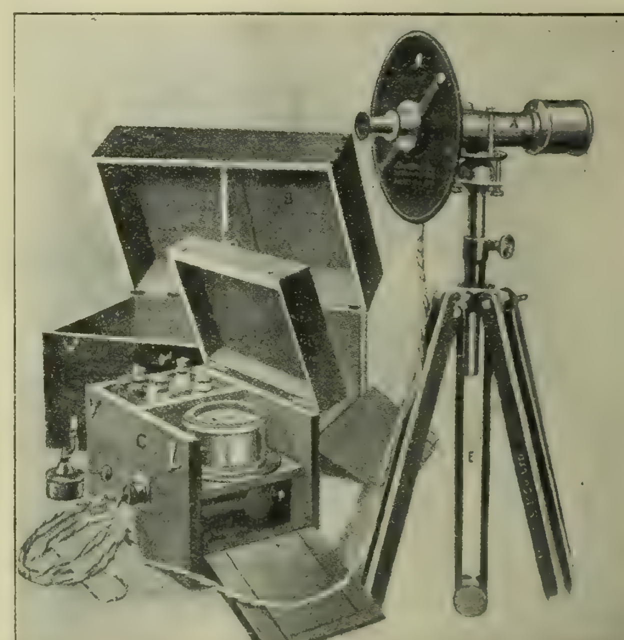


Fig. 14.

case C is a 4-volt accumulator, an ammeter, and a regulating rheostat. The standard amylacetate lamp D, when employed for standardisation, is placed in the box C, which is provided with fittings for holding the pyrometer during the adjustment.

The following are the standard ranges of temperature for which the pyrometers are calibrated :—

I. Single Scale Instrument	700–1,400	deg. Cen.
II. ,, ,, ,, ...	900–2,000	,,
III. Double Scale Instrument ..	700–1,400 and 1,200–2,500	,,
IV. ,, ,, ,, ..	900–1,200 and 1,400–4,000	,,

The last temperature is above that of the positive of the electric arc, which is about 3,500 deg. Cen.

It is usual to have the pyrometers tested at the National Physical Laboratory. A copy of the essential parts of one of the certificates is quoted :—

"Test of Optical Pyrometer No. 9673, with Scale 700–1,400 deg. Cen.

The instrument when first submitted to the laboratory

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 98 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 3 0	0 17 2 0	1 6 1 0	1 15 0 0	2 3 3 0	2 12 2 0	3 1 1 0	3 10 0 0	3 18 3 0	0
1	0 3 14	9 2 14	0 18 1 14	1 7 0 14	1 15 3 14	2 4 2 14	2 13 1 14	3 2 0 14	3 10 3 14	3 19 2 14	1
2	1 3 0	10 2 0	0 19 1 0	1 8 0 0	1 16 3 0	2 5 2 0	2 14 1 0	3 3 0 0	3 11 3 0	4 0 2 0	2
3	2 2 14	11 1 14	1 0 0 14	1 8 3 14	1 17 2 14	2 6 1 14	2 15 0 14	3 3 3 14	3 12 2 14	4 1 1 14	3
4	3 2 0	12 1 0	1 1 0 0	1 9 3 0	1 18 2 0	2 7 1 0	2 16 0 0	3 4 3 0	3 13 2 0	4 2 1 0	4
5	4 1 14	13 0 14	1 1 3 14	1 10 2 14	1 19 1 14	2 8 0 14	2 16 3 14	3 5 2 14	3 14 1 14	4 3 0 14	5
6	5 1 0	14 0 0	1 2 3 0	1 11 2 0	2 0 1 0	2 9 0 0	2 17 3 0	3 6 2 0	3 15 1 0	4 4 0 0	6
7	6 0 14	14 3 14	1 3 2 14	1 12 1 14	2 1 0 14	2 9 3 14	2 18 2 14	3 7 1 14	3 16 0 14	4 4 3 14	7
8	7 0 0	15 3 0	1 4 2 0	1 13 1 0	2 2 0 0	2 10 3 0	2 19 2 0	3 8 1 0	3 17 0 0	4 5 3 0	8
9	7 3 14	16 2 14	1 5 1 14	1 14 0 14	2 2 3 14	2 11 2 14	3 0 1 14	3 9 0 14	3 17 3 14	4 6 2 14	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·17	16·34	24·51	1 4·68	1 12·85	1 21·02	2 1·19	2 9·36	2 17·53	2 25·7	3 5·87	3 14	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 98 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 7 2 0	8 15 0 0	13 2 2 0	17 10 0 0	21 17 2 0	26 5 0 0	30 12 2 0	35 0 0 0	39 7 2 0	0
10	0 8 3 0	4 16 1 0	9 3 3 0	13 11 1 0	17 18 3 0	22 6 1 0	26 13 3 0	31 1 1 0	35 8 3 0	39 16 1 0	10
20	0 17 2 0	5 5 0 0	9 12 2 0	14 0 0 0	18 7 2 0	22 15 0 0	27 2 2 0	31 10 0 0	35 17 2 0	40 5 0 0	20
30	1 6 1 0	5 13 3 0	10 1 1 0	14 8 3 0	18 16 1 0	23 3 3 0	27 11 1 0	31 18 3 0	36 6 1 0	40 13 3 0	30
40	1 15 0 0	6 2 2 0	10 10 0 0	14 17 2 0	19 5 0 0	23 12 2 0	28 0 0 0	32 7 2 0	36 15 0 0	41 2 2 0	40
50	2 3 3 0	6 11 1 0	10 18 3 0	15 6 1 0	19 13 3 0	24 1 1 0	28 8 3 0	32 16 1 0	37 3 3 0	41 11 1 0	50
60	2 12 2 0	7 0 0 0	11 7 2 0	15 15 0 0	20 2 2 0	24 10 0 0	28 17 2 0	33 5 0 0	37 12 2 0	42 0 0 0	60
70	3 1 1 0	7 8 3 0	11 16 1 0	16 3 3 0	20 11 1 0	24 18 3 0	29 6 1 0	33 13 3 0	38 1 1 0	42 8 3 0	70
80	3 10 0 0	7 17 2 0	12 5 0 0	16 12 2 0	21 0 0 0	25 7 2 0	29 15 0 0	34 2 2 0	38 10 0 0	42 17 2 0	80
90	3 18 3 0	8 6 1 0	12 13 3 0	17 1 1 0	21 8 3 0	25 16 1 0	30 3 3 0	34 11 1 0	38 18 3 0	43 6 1 0	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	43 15 0 0	89 10 0 0	131 5 0 0	175 0 0 0	218 15 0 0	262 10 0 0	306 5 0 0	350 0 0 0	393 15 0 0	437 10 0 0	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 99 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 3 10	0 17 2 20	1 6 2 2	1 15 1 12	2 4 0 22	2 13 0 4	3 1 3 14	3 10 2 24	3 19 2 6	0
1	0 3 15	9 2 25	0 18 2 7	1 7 1 17	1 16 0 27	2 5 0 9	2 13 3 19	3 2 3 1	3 11 2 11	4 0 1 21	1
2	1 3 2	10 2 12	0 19 1 22	1 8 1 4	1 17 0 14	2 5 3 24	2 14 3 6	3 3 2 16	3 12 1 26	4 1 1 8	2
3	2 2 17	11 1 27	1 0 1 9	1 9 0 19	1 18 0 1	2 6 3 11	2 15 2 21	3 4 2 3	3 13 1 13	4 2 0 23	3
4	3 2 4	12 1 14	1 1 0 24	1 10 0 6	1 18 3 16	2 7 2 26	2 16 2 8	3 5 1 18	3 14 1 0	4 3 0 10	4
5	4 1 19	13 1 1	1 2 0 11	1 10 3 21	1 19 3 3	2 8 2 13	2 17 1 23	3 6 1 5	3 15 0 15	4 3 3 25	5
6	5 1 6	14 0 16	1 2 3 26	1 11 3 8	2 0 2 18	2 9 2 0	2 18 1 10	3 7 0 20	3 16 0 2	4 4 3 12	6
7	6 0 21	15 0 3	1 3 3 13	1 12 2 23	2 1 2 5	2 10 1 15	2 19 0 25	3 8 0 7	3 16 3 17	4 5 2 27	7
8	7 0 8	15 3 18	1 4 3 0	1 13 2 10	2 2 1 20	2 11 1 2	3 0 0 12	3 8 3 22	3 17 3 4	4 6 2 14	8
9	7 3 23	16 3 5	1 5 2 15	1 14 1 25	2 3 1 7	2 12 0 17	3 0 3 27	3 9 3 9	3 18 2 19	4 7 2 1	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·25	16·5	24·75	1 5	1 13·25	1 21·5	2 1·75	2 10	2 18·25	2 26·5	3 6·75	3 15	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 99 lbs. per foot.

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Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 8 1 16	8 16 3 4	13 5 0 20	17 13 2 8	22 1 3 24	26 10 1 12	30 18 3 0	35 7 0 16	39 15 2 4	0
10	0 8 3 10	4 17 0 26	9 5 2 14	13 14 0 2	18 2 1 18	22 10 3 6	26 19 0 22	31 7 2 10	35 15 3 26	40 4 1 14	10
20	0 17 2 20	5 6 0 8	9 14 1 24	14 2 3 12	18 11 1 0	22 19 2 16	27 8 0 4	31 16 1 20	36 4 3 8	40 13 0 24	20
30	1 6 2 2	5 14 3 18	10 3 1 6	14 11 2 22	19 0 0 10	23 8 1 26	27 16 3 14	32 5 1 2	36 13 2 18	41 2 0 6	30
40	1 15 1 12	6 3 3 0	10 12 0 16	15 0 2 4	19 8 3 20	23 17 1 8	28 5 2 24	32 14 0 12	37 2 2 0	41 10 3 16	40
50	2 4 0 22	6 12 2 10	11 0 3 26	15 9 1 14	19 17 3 2	24 6 0 18	28 14 2 6	33 2 3 22	37 11 1 10	41 19 2 26	50
60	2 13 0 4	7 1 1 20	11 9 3 8	15 18 0 24	20 6 2 12	24 15 0 0	29 3 1 16	33 11 3 4	38 0 0 20	42 8 2 8	60
70	3 1 3 14	7 10 1 2	11 18 2 18	16 7 0 6	20 15 1 22	25 3 3 10	29 12 0 26	34 0 2 14	38 9 0 2	42 17 1 18	70
80	3 10 2 24	7 19 0 12	12 7 2 0	16 15 3 16	21 4 1 4	25 12 2 20	30 1 0 8	34 9 1 24	38 17 3 12	43 6 1 0	80
90	3 19 2 6	8 7 3 22	12 16 1 10	17 4 2 26	21 13 0 14	26 1 2 2	30 9 3 18	34 18 1 6	39 6 2 22	43 15 0 10	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	Weight.
	44 3 3 20	88 7 3 12	132 11 3 4	176 15 2 24	220 19 2 16	265 3 2 8	309 7 2 0	353 11 1 20	397 15 1 12	441 19 1 4	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

was provided with an angular scale only, and was accompanied by a statement of the temperature range desired.

The lamp setting point was fixed at the position marked 'Cal.' on the scale ring, viz., 60 deg. of arc. Observations were taken on an electric furnace at a series of steady temperatures under conditions approximating to those necessary for obtaining true 'black body' radiation. The data for the direct reading temperature scale were calculated from the results so obtained.

After graduation of the scale ring by the makers from the above figures the instrument was finally checked in the laboratory. Its behaviour was satisfactory, and the readings up to 1,400 deg. were found to be correct within the limits of error of setting in technical practice, which may be taken to be generally ± 10 deg. Cen."

Electrical Resistance Thermometers.

The measurement of the electrical resistance of wires at various temperatures furnishes an accurate method of determining both high and low temperatures, which must now be discussed in detail.

The relation between the resistances R*o* and R*t* at 0 deg. Cen. and *t* deg. Cen. respectively is expressed by the expression

$$Rt = Ro \quad (1 + at + \beta t^2),$$

where a and β are temperature coefficients to be determined experimentally. The usual method of measurement requires the use of a Wheatstone Bridge outfit. The standard diagram of electrical connections is shown in Fig. 15, where P, Q, R and X are resistances connected at A, B, C and D. Between A and D is a battery E usually of two or three dry cells, whilst between B and C is a delicate galvanometer G. According to the principle of the Bridge, when

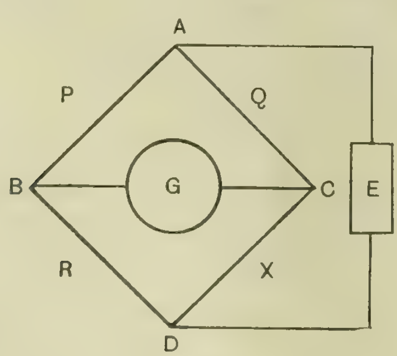


Fig. 15.

$$P/Q = R/X$$

no current passes through the galvanometer, hence when P, Q and R are known X can be calculated. The simplest case is when P = Q, then R = X.

Let us suppose, for example, that a coil of insulated copper wire of exactly 100 ohms. at 0 deg. Cen. be heated first to 100 deg. Cen., and then to 200 deg. Cen., and that the resistance is measured at these temperatures. Denoting these respective values by R_{100} and R_{200}, then

$$R_{100} = 100\ (1 + 100\ a + 100^2\ \beta)$$
$$R_{200} = 100\ (1 + 200\ a + 200^2\ \beta).$$

From these equations the values of a and β can be calculated. It is found that the values depend on the purity and hardness of the wire. For a certain sample of copper wire the calculated values were :—

$$a = 0{\cdot}00387$$
$$\beta = 0{\cdot}00000901.$$

The latter coefficient being small it may be neglected in calculations when the temperature range is relatively small.

Example 1.—A copper wire is 100 ohms. at 0 deg. Cen., and 110 ohms. at a higher temperature. Find its value assuming $a = 0{\cdot}004$.

Answer :—

$$110 = 100\ (1 + 0{\cdot}004t)$$

$$\text{and } t = \frac{110-100}{100 \times {\cdot}004} = 25 \text{ deg. Cen.}$$

Example 2.—A copper coil is 20 ohms. at 60 deg. Fah., and is raised to 260 deg. Fah. What is now the resistance with a as above ?

Answer. — The temperature coefficient in the Fahrenheit scale is :—

$$0{\cdot}004 \times \frac{5}{9} = 0{\cdot}0022$$

and

$$20 = R_{32}\ (1 + (60 \times 002)\ )$$
$$R_{260} = R_{32}\ (1 + (260 \times 0022)\ )$$

therefore

$$R_{260} = 20\,\frac{1 + \ (60 \times 0022)}{1 + (260 \times 0022)}$$
$$= 20\ (1 + (200 \times 002)\ ) \text{ approximately}$$
$$= 28{\cdot}8 \text{ ohms.}$$

(*To be continued.*)

Iron Industries in South Africa.—In view of the recent discussion in the Union Parliament on the contract with the Pretoria Iron Mines Ltd., the following review of the production of the iron and steel industry, taken from the annual report of the Secretary for Mines and Industries, is of interest. The Union Steel Corporation's works at Vereeniging had a successful year, the production being 10,318 tons of open-hearth steel from scrap or pig, the value of the output being £200,753. The newly-installed $3\frac{1}{2}$-ton Heriult electric furnace had ten months' work, and produced 1,394·5 tons of steel of the total value of £30,485. Most of this output goes to the mines in the form of shoes, dies, rails, and tube-mill bars. The Corporation are now arranging to forge the shoes and dies after casting by means of a 600-ton hydraulic press. The Transvaal Blastfurnace Co. produced 676 tons of pig iron, of the value of £2,855. The output of pig iron by the Pretoria Ironworks was 1,286 tons, of the value of £9,845. It is intended to increase the capital and to work on a much larger scale, and to produce not only pig iron, but also steel in the form of angles, bars, tees, beams, rails, sleepers, etc. At the Dunswart Iron and Steel Works little alteration has taken place. During the latter part of last year an 8 in. roller mill was installed, and the average monthly output increased to about 550 tons of bar, rod, and angle iron. The total output was 5,596 tons, of the value of £139,660. The total output of shoes and dies by the Witwatersrand Co-operative Smelting Works was 1,043 tons, of the value of £22,400. The Newcastle Iron and Steel Ltd. are erecting plant at Newcastle (Natal) to produce pig iron from ore, open-hearth steel, and iron and steel castings up to 20 tons weight. This company expects to start smelting in October, 1920. It will be seen from the above summary of operations that the production of iron and steel is now attracting great attention, and that the country is on the eve, apparently, of large expansion in this new branch of industry. The total value of iron and steel goods produced in South Africa in 1919 already amounted to the respectable total of £405,798.—Reuter.

DEVELOPMENT OF GAS POWER.

By John D. Troup, M.I.Mech.E.

The development of gas-power is dependent on the more general carbonisation of coal, and there can be little doubt that we are about to witness big developments along those lines. The recent Act of Parliament giving authority for the supply of gas on a heat-unit basis in place of a candle-power basis will enable gasworks to reorganise to produce gas on a more economical basis and so extend their present activities. Then there is the developments in low-temperature carbonisation by quite another organisation, and already several very large plants are being installed. Then, again, there is the increasing use of coke-oven gas for town's supply, the great developments in gas heating for furnace work, and developments in gas producers, notably the automatic Smith producer.

When coal is subject to distillation in a retort it is split up into its different constituents, which are recovered during the process of purifying the gas which is given off. These various constituents total up to a much greater monetary value than that of the original coal ; in some cases the value is double that of the cost of the original coal. But here there is another point to be borne in mind : the resulting fuels from the process of distillation —namely, coke or smokeless fuel, gas, tar oils, and motor spirit—can each be used to give up their heat value in a much more efficient manner than can be done with the original coal. This means, of course, that the heat value of the coal can be used more efficiently by first splitting it up into its constituents and using them separately. The more scientific use of coal by carbonisation results in other economies which might be termed secondary, but are of great importance to the life of the nation. These include a reduction in the pollution of the atmosphere, saving in labour, larger output, and saving in transport.

The saving in labour when using a gaseous fuel does not require any explanation ; its operation is merely the regulating of valves. Larger output is due to obtaining a higher mean temperature with gas, there being no cold coals to enter the furnace, and the air supply can be much better controlled than with a coal furnace. The saving in transport is due to the gaseous fuel being pumped through underground pipes.

Turning now to the actual plants in operation, the modern by-product coke oven may be taken as the pioneer gas plant for supplying large volumes of gas for industrial purposes. The coke oven, as its name implies, is primarily for producing coke, which is used for metallurgical purposes. During the process of coke-making the valuable by-products of the coal are recovered, including the rich gas which is distilled off. Approximately one-half of this gas is used for heating the coke oven itself, and the remainder is available for any outside purpose. Advantage has been taken of this supply to feed the industries in the locality of the works and also to supplement the local gasworks supply. The town of Middlesbrough receives its gas supply almost wholly from the district coke ovens. During the war a gas main was laid between the Tinsley Park Colliery, near Sheffield, and one of the town's gasworks. This particular works now receives some 25 per cent of its production from the colliery coke ovens. It is instructive to note in this case that the colliery have now stopped sending 30,000 tons of coal per annum to this gasworks, but send the equivalent of 40,000 to 50,000 tons in the form of gas. This example gives a good idea of how gas distribution effects economy in transport.

Low-temperature distillation of coal is a comparatively new process which opens up huge possibilities for the industrial supply of gaseous fuel. So important is this matter that special plant is being installed at H.M. Fuel Research Station in order to carry out systematic tests of different plant by this process. The whole subject is being gone into in a very comprehensive manner, including the organisation of a survey department for collecting and registering all information relative to the types of coal available in the various coal-mining districts.

The principal concern who are developing this system on a commercial basis is the Low-temperature Carbonisation Limited. They are already supplying the Yorkshire Electric Power Company with gas for firing their steam boilers from the plant at Barnsley, and this plant will carbonise some 500 tons of coal per day. Negotiations are being completed for large plants at Glasgow and Sheffield, showing that considerable progress has already been made.

The leading features of this process are that the total value of the products of carbonisation are greater than by any other process. A large percentage of tar oils and motor spirit are recovered, and the residue left in the retorts is not ordinary coke but smokeless fuel, which can be burned in an ordinary firegrate. The actual products into which one ton of coa lis carbonised are as follows :—Smokeless fuel ·7 ton, gas 7,000 cubic ft. of 600 B.Th.U., sulphate of ammonia 20 lb., tar and oils 16 gallons, motor spirit three gallons.

Turning now to the application of gas, there are three principal fields—namely, heating steam boilers, heating furnaces, and supplying gas engines.

A great deal of experience has been gained in applying gas for steam-raising, and special burners have been evoked for this purpose, but it is probable with the more universal adoption of gaseous fuel that boiler design will undergo some changes. An example of special design is that making use of the principle of surface combustion in the Bonecourt boiler, where the fire tubes are partly filled with solid material which is raised to incandescence by the burning gases. This boiler has given efficiencies of over 90 per cent.

The economies to be effected by gas-firing boilers are very similar to those obtained by oil firing. Owing to the more perfect control of the air supply with gas firing the efficiency of the boiler furnace is much greater than with coal firing, and the temperature is constant and higher than with coal, and, in addition, peak loads can be taken more rapidly. For these reasons the capacity of the boiler is increased, which means that a lower capital outlay is required in the case of gas firing. Capital is also saved by the elimination of coal and ash handling plant and the ground space occupied by these and the coal and ash, and there is also a considerable saving in labour.

The uses of gas for furnace and heating work are too numerous to mention in a short article ; there is scarcely

any industry which does not now use gas for some section of its operations, such as annealing, heat treatment of steel, tempering, welding, melting metals, brazing, soldering, japanning ovens, sugar boilers, thread singeing, hat presses, ironing, &c.

The modern gas engine, made in sizes up to 6,000H.P., is capable of using every class of gas which is at present available. Gas can be used much more efficiently in the cylinder of an engine than when burnt under a steam boiler, but so far the gas engine has a limited field of application. In the first place it is not a commercial proposition for large electric-power stations, because units of 20,000 to 50,000 H.P. are required, so that for this field the steam turbine has no rival. Then there are certain industries where large quantities of steam are required for process work, when a steam boiler must be installed. When, however, relatively small quantities of steam or hot water are required, these may be obtained from the gas engine by using the heat of the exhaust and jacket water.

Gas-engine design has settled down to three principal classes, much in the same manner as the steam engine—namely, slow-speed horizontal type, vertical slow-speed type, and the high-speed enclosed engine. There is no industrial process where the gas engine cannot be successfully applied from a practical point of view, from driving an ordinary line shaft to running electric alternators in parallel.

Finally, there is the problem of gas distribution, and this matter will, of course, require careful consideration with the increasing use of industrial gas. The present method of low-pressure distribution will gradually be replaced or at least supplemented by high-pressure gas mains, so as to reduce the capital sunk underground.

The question of this distribution is of great importance because the higher its efficiency the greater will be the saving over the present cost of transporting the solid coal. The total cost of high-pressure gas distribution would appear to compare very favourably with a similar capacity electric distribution, and it is possible the gas system would be the cheaper, so that there would appear very little hope of electricity replacing gas as a heating agent.—*Manchester Guardian.*

Mr. L. E. Little, founder and managing director of Northern Ball-Bearings Ltd. in this country, has recently joined forces with the firm of Ransome & Marles Bearing Co. Ltd., and is at present busily engaged in introducing several new features in ball-bearing design. He will have his headquarters at the London office of the company, at 64, Mortimer Street, Great Portland Street, W.1.

Economy of Oil Fuel for Engines.—The figures of oil consumption, which have hitherto been withheld by both the Great Central and the London and North-Western Railways, have, in the case of the last-named company, now been issued. They indicate that, as compared with an average consumption of about 70 lb. of coal per mile with the same load on a similar run, the locomotive working on oil fuel with a trainload of 294 tons consumed 32 lb. of oil per mile, or 10·88 lb. per 100-ton miles. Nor should the economy realised end with the saving of fuel, as the oil-fired locomotive requires far less cleaning than a coal-burning engine, and the conversion of a large number of locomotives from coal to oil, which could be effected in a very short space of time, should be associated with a considerable saving of labour charges in running sheds and engine houses. Much would, of course, depend on the relative prices of coal and oil fuel, and it is certain that any attempt to convert the whole of the existing coal-fired engines on British railways to oil burning would be associated with a rise in the price of the fuel which might counterbalance the savings in other directions.

THE MACHINIST AND THE GUARD.

By Val Klammer.

Any mechanism exposed to hazardous contact is like a savage dog, harmless only when securely muzzled.

In the campaign against accidents much importance is placed upon the proper guarding of dangerous machinery, and it is only right that such should be the case ; no one can deny that unguarded machinery takes a heavy toll of human life and causes much unnecessary suffering. If a man is injured by a train of gears, a guard over the gears will prevent many injuries to other men, but there is no magic charm about it, no guarantee that it will always effectively protect the worker. It is a fallacy to believe that any dangerous condition can be removed by the erection of a guard.

Safety in a machine shop is not obtained by simply placing guards on the machines, no matter how expensive the guards may be. The desirable state of safety and absolute freedom from accidents is only obtainable by guards plus something else, a something without which the installation of safety devices is but a waste of time, money, and material.

A large machine shop in Pennsylvania was inspected by a State inspector who presented a voluminous report calling for numerous guards on the various machines. The management expressed its surprise in suitable terms, but finding that state laws demanded the guarding required gave its approval to the order. Thousands of dollars were spent on the guards, and Mr. State Inspector finally pronounced the shop to be thoroughly guarded in accordance with the standards. Every gear, every belt and pulley, did its little bit inside a cage.

One year later Mr. State Inspector again appeared at the machine shop and presented a report which caused more consternation than the first. Of the many hundred expensive guards only a few were found to be intact ; the rest were missing or in a badly broken condition. This made the management gloomily seek an answer to the eternal question "What's the use ?" and think bitter things about the machinists for whose benefit the guards were installed. That is where the management made its big mistake ; the guards were not installed for the benefit of the machinists but because state laws demanded it. The wastage of guards was due to the lack of one very important thing—the *co-operation* of the worker.

One curious fact which is repeatedly forced upon the attention of those engaged in accident prevention is that the first man to remove a safety device or render it ineffective is the man for whose protection the device is provided. A machine guard is primarily provided for the protection of the machinist, and yet he will frequently remove the guard and forget to replace it. This neglect or thoughtlessness is a serious matter ; in the State of Pennsylvania the removal of a safeguard is considered a misdemeanour punishable by fine or imprisonment.

Employers have frequently accused workers of lacking interest in their own safety, and there is some degree of truth in the accusation, but it is not entirely through lack of interest that guards are lost or destroyed. The "take-a-chance" spirit is peculiarly American, and is undoubtedly the cause of many accidents, but it is not this spirit which is chiefly responsible. The real reason is that there exists in every man a certain love

for the old order and a distrust of the new, a preference for things as they have been for many years. Old "Bill" now runs a modern lathe, but he has a secret longing for his old machine, the rattling product of a byegone age, and proudly tells of what he did, not what he does.

Opposition to safety devices is natural and should be looked for when any devices are to be installed, but the machine guard will never be of permanent value until the machinist has overcome this feeling of opposition. The first step in guarding any dangerous mechanism is not in designing the guard, but in convincing the machinist that the guard is necessary for his safety and the safety of his fellow-workers. Before a safety device is installed it must be "sold" to the men who will profit by it. There is another reason for opposition to safety devices, a reason which is frequently overlooked by those who accuse the machinist of negligence—and that is the bad design of guards. No machinist can be expected to take great care of anything which interferes with production or prevents quick access to any part of the machine.

In the installation of machine guards new hazards are sometimes created. The guard may be placed too near moving parts and be caught and destroyed, or it may not give sufficient clearance to the machinist's hands while operating the machine. If a machinist pulls a lever or turns a wheel and lacerates his hands against the guard the great chances are that the guard will soon find its way to the scrap pile.

The ideal guard is strong and will not fall to pieces under the vibration and heavy usage of a machine shop: it is made of some material which will not obscure the parts guarded; it is well provided with doors to permit immediate access to the machine for the incidental changing of gears and the oiling of bearings. It takes the guard plus the co-operation to produce safety.—*American Machinist.*

THE BENNIS STEAM TABLES.

The chief value of these tables, published by Messrs. Ed. Bennis & Co. Ltd., Little Hulton, Bolton, and 28, Victoria Street, London, S.W.1, lies in their extreme practical nature. They are convenient in every sense of the word, and offer a ready source of reliable information. The special features of the compilation may be briefly described. The properties of steam tabulated are:—

(1) Saturation temperature corresponding to given gauge pressures;

(2) Total heat of saturated steam above water at 32 deg. Fah. corresponding to given gauge pressures;

(3) Total heat of water above water at 32 deg. Fah. corresponding to given temperatures;

(4) Factors of equivalent evaporation as from and at 212 deg. Fah. corresponding to given actual conditions of evaporation.

It has been found advantageous to devote the whole of one table to each of the four properties, instead of putting them into separate columns of a general table.

New Plymouth Hydro-Electric Scheme.—In response to an enquiry, the Municipal Council at New Plymouth (New Zealand) has supplied the following particulars of proposed extensive additions to the local hydro-electiric scheme:—The completed scheme provides for (1) an intake on the Waiwakaiho River, in the vicinity of the Junction Road, 262·5 ft. above the level of the tailwater at the existing power-house, and the conveyance of the water up to a maximum of 200 cubic feet per second by means of a tunnel, called No. 1 Tunnel, 1,805 ft. long, into the valley of the Mangamahoe stream. (2) The construction of a weir across the Waiwakaiho River at the intake to No. 1 Tunnel, for the purpose of raising the head of water at the tunnel. (3) The building of a dam 110 ft. high and 610 ft. long on the crest, with a reinforced concrete core wall across the Mangamahoe stream, to impound the waters of the Mangamahoe and also the Waiwakaiho in a storage reservoir having an area of 95 acres and a capacity of 50,000,000 cubic feet, with a 15 ft. draw-off. (4) The building of two embankments 1,400 ft. long on the south side of the proposed reservoir to prevent the water overflowing the adjacent lands. (5) The construction of a second tunnel (called No. 2 Tunnel), approximately 4,010 feet long, to convey the water from the storage reservoir to the forebay overlooking the power-house. The level of this tunnel will be placed so that there will be a draw-off of 15 feet. The construction of a forebay or surge chamber, also the laying of three penstock pipes 5 ft. internal diameter, supported on concrete cradles, together with all necessary expansion joints, anchors, etc., also the conveyance of the water from the termination of the five feet penstock pipes by branch pipes to the various units at the power-house. The units when the full force of the station is in use are taken as follows: Two units of 1,000 H.P. each, 2,000 H.P.; two units of 1,500 H.P. each, 3,000 H.P.; two units of 2,000 H.P. each, 4,000 H.P. (6) The construction of a new power-house, consisting of generator floor, switchboard platform, workshop room, shift room, telephone office, together with tail race, to link up with the existing tail race and enlargements of the latter. The power developed will be 9,000 H.P. The estimated cost of the complete scheme is £233,308, excluding present works transmission and reticulation, the capital cost of which to date is £87,500. It is not intended to proceed with the complete scheme immediately. To commence with, and until a market is obtained for the output, a portion only of the extension will be put in. The partial scheme will produce 3,000 H.P. at the power station, and will form a complete section of the full development. The following is a description of the partial scheme: Under this scheme it is proposed to convey 150 cusecs to the present power-house at the increased elevation of the proposed new forebay to the existing power-house, thereby giving 2,000 H.P. additional to the 1,050 H.P. now in use. The scheme includes the No. 1 and No. 2 tunnels, being portions of the completed scheme, and conveying the water, viz., 150 cusecs, from one to the other by 3,952 ft. of open race cut in the hillside and 550 ft. of pipes across the Mangamahoe stream. From the forebay of No. 2 Tunnel the water will be carried to the present power-house by means of penstock pipes. The race and pipes conveying the water between the two tunnels, estimated to cost £7,535, are not classed as permanent works. The balance of the works form a portion of the completed scheme. The partial scheme is estimated to cost £112,000, excluding the cost of the present works, etc. The partial scheme is now in course of construction, the intake and intake tunnel (termed No. 1 Tunnel) in the description) being well in hand. Tenders close early in July for the additional plant now required. Further plant will be put in as the output is sold, and tenders will be invited in the usual way. Tenders will shortly be invited for the construction of Tunnel No. 2, forebay or surge chamber, and for the penstock pipes required. Contracts have also been let for transmission and distribution line cables, poles, cross arms, and insulators. The complete scheme, when in full operation, will probably be sufficient to meet the needs of the whole of the provincial district of Taranaki for many years.—Reuter.

Well-known Leeds Engineer's Death.—Sir John McLaren, one of the most prominent men in the industrial life of Leeds, died at his residence in Headingley on the 12th October. He was head of the well-known engineering firm of Messrs. J. and H. McLaren, Midland Engine Works, Hunslet, agricultural implement and steam plough makers. Sir John, who was 71 years of age, was for many years associated with the Leeds Chamber of Commerce, and was chairman of the Board of Control responsible for the erection of the National Ordnance Shell Factory at Leeds. He was also chairman of several engineering associations, and was recognised as an authority on all matters pertaining to the trade.

AMERICAN NOTES.

A report reaching America that Mr. J. H. Gardner, managing director of the Colliery Investment Trust Ltd., London, has closed contracts for the purchase of 35,000,000 tons of American coal for export delivery within five years has been received with incredulity. It is not denied that Mr. Gardner may have closed the contracts; rather it is doubted if he can get that amount of coal delivered within the time named. Mr. Gardner's integrity is not in question, but, as our coal paper, "The Black Diamond," says: "If Mr. Gardner exports 7,000.000 tons of American coal to Europe in any one year, it will mean that he will take over a considerable part of the business that a hundred or more American coal concerns have built up over a long period of years. Last year our total exports over the Atlantic seaboard reached an aggregate of only 6,150.000 tons. Hundreds of shippers contributed to this total, and we do not believe that these people are going to get out of the export coal business."

* * *

In this connection statistics published by the Italian Chamber of Commerce may be of interest :—

On October 31st. 1919, the companies operating electrical plants in Italy were 306. with an aggregated capital of nearly 1,500,000,000 lire. They were distributed as follows :—

	Plants.	Lire.
Piedmont	31	112 394 500
Lombardy	94	526 811 995
Venetia	24	120 268 000
Liguria	17	168 830 000
Emilia	8	26 700 000
Tuscany	22	132 494 700
Marche	12	12.505 000
Umbria	3	1.900 000
Latium	24	117.300 000
Abruzzi Molise	8	2 297 000
Campania	30	183 260.050
Apulias	12	8.454.000
Calabria	11	6.266.000
Sardinia	1	120 000
Sicily	9	18.430.793
Total	306	L.1,458,032,638

* * *

The July average weekly earnings for the 11 chief industry groups are, in the State of New York, as follows :—

	Dols.
Stone, clay, and glass	28·77
Metals and Machinery	31·58
Wood manufactures	27·77
Furs, leather, and rubber goods	26·81
Chemicals, oils, and paints	27·68
Paper manufacture	32·60
Printing and paper goods	29·27
Textiles	23·47
Clothing	24·55
Food, beverages, and tobacco	26·27
Water, light, and power	34·32
Total (all industries)	28·49

* * *

Contracts awarded during August for industrial buildings, which include factories, power, and heating plants in the 25 States comprising the North Eastern quarter of the United States, as reported by the F. W. Dodge Company, number 710, with a valuation of 64,689,900 dols.

* * *

Imrie & Co. have purchased the Foundation Co. tract of about 520 acres situated on the Savannah River, just below the cotton compress tract. It is said that the northerly part of this property will be sold to the Jules Cahlat interests, who will build a coal-handling plant capable of exporting a minimum of 2.000,000 tons of coal per year.

* * *

Although it is estimated that over 500.000.000 metric tons of iron are deposited beneath the surface of the Philippines, according to an article in the trans Pacific, the Customs figures show that iron and steel and the manufactures thereof constitute nearly one fifth of the total importations of the islands. The potential possibilities of the Surigao iron ore field, located on the north eastern coast of the island of Mindinao, are believed to rival those of the largest deposits of the world. The 500,000,000 metric tons, constituting about 99 per cent of the total deposits of the islands, are distributed over an area of 100 square kilometres. Some 275,000,000 tons are estimated to be fairly close to points on the coast and 130,000,000 tons lie within a short distance of Dajikan Bay, which would afford excellent natural harbour facilities. Operations on a small scale in the Province of Bulacan have been conducted by small smelters and native furnaces.

* * *

At the annual Convention of the Steel Treating Research Society and the American Steel Treaters' Society, held in Philadelphia recently, an amalgamation of the two organisations was effected. The new organisation will be known as the American Society for Steel Treating. At one of the meetings Mr. Guy P. Bible said :—

"For 50 years industries in this country were very large importers of Swedish iron, and this material entered into work where the requirements were extreme in the way of resistance to fatigue and maximum elongation. The war necessarily shut off this importation, and not caring to turn to another iron, we have made some progress in the way of the heat treating of soft steels and alloy steels for work where the Swedish iron formerly went in.

"In addition our work has largely been along the lines of soft steel and high-grade straight carbon machinery steels, and we have taken advantage of the opportunities given to suggest heat treatment and assist customers to inaugurate and carry through such heat treatment to success."

* * *

In view of rumours that have been recently circulated in this country that Great Britain was considering taking steps to place an embargo on exports of crude rubber, it is interesting to gather from figures furnished by the Rubber Association of America that our crude rubber importations during the month of August show an increase over those of the corresponding month of last year. The totals for August this year were : Plantation, 12.730 tons; Africans, 13 tons; Central and Guayule, 231 tons; Paras, 590 tons.

* * *

A complete four-year course in pulp and paper making is offered by the New York College of Forestry, Syracuse.

* * *

A complete, portable, self-contained electric-arc welding outfit for either land or marine work has been mounted on the chassis of a motor-truck by a New York marine contracting company. It is the first of its kind in this country.

* * *

Here, in America, we have many reasons for watching your coal crisis with anxious perplexity. Whenever labour in England scores a notable point, our workers try for the same concession plus. Then, too, your slackened production and increased costs of coal production have been the main reasons for America's enormous strides in the coal export field during the last four years or so.

* * *

Our colliery owners were not altogether unprepared to take advantage of the war-made opportunity. They knew, or at least some of them did, who back in 1912-13 had made a close study of conditions and requirements in coal-importing countries, as well as of the mining costs here and there, that their production per man was far and away above the British average. They were quite well aware of the circumstance that labour-saving machinery was in much more common use in America than in Britain. Competition, on the basis of cost of mining, was no bar to their competitive efficiency even in pre-war times

They knew that "Pochahontas" and similar qualities of American bituminous coals was fully equal to Welsh, so far as the number of heat units, etc., were concerned, nor were they unmindful of the one drawback to their fuel That it was more friable than Welsh coal, but they were persuaded that the practical difficulties incident to this disadvantage would not be difficult to overcome. They are not allowed to remain uninformed of the great influence coal carrying has on the successful operation of a merchant marine in which the taxpayer has put hundreds of millions of dollars. This lengthy comment then quite accounts for our coal and shipping interests keeping an interested eye on your coal controversy.

Industrial managers are just as alert. An annoying shortage for power purposes in some districts is laid at the door of the exporter and the fancy prices he has been paying.

THE INDUSTRIAL SITUATION.

[By a Labour Correspondent.]

Never in the history of Great Britain has the outlook in the industrial world been so dark and forbidding as is the case to-day. Look where you will, there is nothing but strikes and threats of strikes, disputes and cavilling, and far and wide a general feeling of unrest, coupled with a sense of impending disaster.

At the moment the most serious danger that threatens is the position in the coal trade, with all its paralysing effects on the entire industrial community. Winter will soon be upon us, and a shortage of household fuel will mean death to hundreds and desolation to thousands.

As to the responsibility for such as state of things, that in itself proves a difficult problem, so far as the allocation of such responsibility is concerned. The miners insist that the coal-owners are to blame, the position having arisen through their greed and rapacity.

On the other hand, the employers lay the blame upon the shoulders of the miners, accusing the latter of "ca' canny" methods, time losing, and general slackness of conduct.

Certain sections of the Press accuse the extremists and hotheads, and would have us believe that the present position has been brought about owing to the violent propaganda of the socialistic element of the unions, who, though few in number, influence the steady-going members by their loud-mouthed agitations and plausible speeches. Some journals even go to the length of accusing the miners of being led and financed by Moscow. All this is mere bunkum, and most of us know it.

It just amounts to this, that no genuine attempt has yet been made by either side to understand each other. The other fellow's point of view has never been seriously considered, and until mutual help and mutual forbearance are exercised, I am very much afraid we shall fail to reach anything approaching a reasonable settlement.

But behind all this there lurks another very serious menace, and that is the prospect of strife in the engineering industry. If there should be trouble it will certainly have a most disastrous effect upon our commerce for years to come. The competition in the world's markets is keener than ever it was before, and a stoppage now would give our foreign competitors an unique opportunity to oust us in many directions.

The workmen claim that they are being unfairly treated; that the skilled men are infinitely worse off than those in any other industry. While transport workers, miners, carpenters and bricklayers have received every consideration, their just claims for a wage equivalent to the ruling prices of commodities has been abruptly turned down. There is widespread dissatisfaction, and a feeling of regret that they as a body did not enforce extravagant claims during the war, when it would have been impossible for the employers to have resisted such. Consequently, they are now claiming advances which will raise their wages to a standard similar to that of other skilled trades.

Against this the employers urge that the state of trade does not warrant any further increase, having regard to the high price of materials, and the shortness of hours worked.

On the other hand, the men claim that the present slump in the trade is a fictitious one. That the stoppages on the Tyne and elsewhere are being deliberately engineered for a set purpose. That evidence of the vast profits made during the war by the employers is to be found in the large extension of plant and premises now going on. Further, that while prices of commodities have gone up 160 per cent, wages in the engineering trade have only advanced 120 per cent; consequently, they are far worse off than they have ever been before.

These are the opinions, not of extremists, but of level-headed men of mature years and intelligence. And, so the matter stands for the present. No drastic steps, beyond the embargo on overtime, have yet been taken, and it is to be hoped that common sense will prevail on both sides, and that action which can only have an adverse effect on the whole industry will not be endorsed by either side.

There is an unanimous opinion on the part of the workers of this country that, though we won the war, we are still losers.

Meanwhile, there is one ray of hope amidst all this darkness, and that is that if the forthcoming Trades Union Congress brings about the formation of a general staff, it may lead to better discipline in the labour movement, and at the same time create a responsible executive, with ample powers to act as a go-between when contentious matters arise between employers and employed.

New Harbour at Holmsund.—The Government has granted a loan of Kr.1,100,000 to the town of Umea for the purpose of constructing a new harbour at Holmsund, near Umea.—Reuter.

VICKERS LTD.

Share capital issued £20,679,040, in £750,000 5 per cent preferred stock, 750,000 5 per cent preference shares, 6,863,587 5 per cent cumulative preference shares (tax free up to 6s. in the £), 12,315,453 ordinary shares, all shares of £1 each, with £1,250,000 4 per cent. 1st moragage debenture stock. Issue of £1,500,000 7 per cent 7-year notes to bearer at 95 per cent, repayable at par on July 1st, 1927. In addition to this firm's extensive establishments at Sheffield, Barrow, Erith, Crayford, etc., all of which contributed their quota during the war, the company holds interests in Wolseley Motors Ltd., William Beardmore & Co. Ltd., the Metropolitan Carriage, Wagon, and Finance Co. Ltd., and the Metropolitan-Vickers Electrical Co. Ltd., formerly the British Westinghouse Co. Ltd. The present issue is intended to provide for expansion, particularly as regards the electrical interests. Dividends have been paid for the last nine years of 10 per cent or over, free of income tax, and as the interest on the present issue only amounts to £105,000 per annum it will be seen that this is covered many times over. The company reserves power to issue a further £2,500,000 similar notes, provided the rate of interest is not higher than on the present issue and the date of maturity not prior to July 1st, 1927. It may redeem the whole or any part of the notes by purchase at any time, or on any half-yearly interest date by drawings at par on giving three months' notice, and it undertakes not to issue any debentures or create charges over its property or assets unless repayment of the notes is a condition of such actions. The fact that there is 4 per cent 1st mortgage debenture stock outstanding of £1,250,000 does not seriously prejudice the issue.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.

The opening meeting of the Institution of Automobile Engineers on October 13th augurs well for the new session. Sir Henry Fowler, K.B.E., was inducted into the presidential chair by the retiring President, Mr. Thos. Clarkson, and gave a most thoughtful address on the relationship between the employer and labour, a subject which concerns the automobile engineer as vitally as any other at the moment. Col. Crompton, as the senior of the seven past presidents present to welcome the new president, emphasised the importance of the occasion in the union between railway interests and the motor industry.

The institution of informal dinners before the meetings promises to be very successful as affording opportunities for the members to meet in a friendly way, and these dinners will now be a regular feature of the session.

The guests at the annual dinner on October 27th will include the officers of all the leading motor organisations, and there are evident signs of joint working between the various motoring interests which is bound to have a good effect on the industry as a whole.

Following on the lines of every other body, the question of an increase in subscriptions had now been pressed to the front, and the matter will be laid before the members at an extraordinary general meeting to be held in November. The amount of the increase suggested is at the flat rate of 10s. 6d. per annum for each grade of membership, as it is considered by the Council that this is the minimum amount which can be asked in order to cope with the very heavy increase in costs which has occurred in all directions. It is hoped that in view of the small amount of the increase no loss of membership will be entailed.

It can now be definitely stated that the report of the Steel Research Committee on the 10 standard automobile steels, published in Report No. 75 of the British Engineering Standards Association, will be issued at the end of this month. The value of the report will undoubtedly be enhanced by the opportunity which will be afforded for its discussion by the paper which is to be given by Mr. J. H. S. Dickenson before the institution on November 10th. This paper will point out the methods adopted during the research, and the reasons for their adoption. One of the most important points will consist in the explanation of what will be called "X" figures—that is, the reconciling of the individual discrepancies in the figures obtained by the different investigators. All those who desire copies of the report, with a view to taking part in the discussion, are asked to make early application to the Secretary of the institution, at 28, Victoria Street, London,S.W.1. The price of the report, which is bound in cloth and contains not only the tables of all the investigators' figures, but a number of coloured charts embodying the figures, is 31s. 6d. (carriage and packing 1s. 6d. extra).

The following is the list of meetings which will be held during the month of November, under the auspices of the Institution of Automobile Engineers :—

Monday, November 1st : Meeting of the Scottish centre at the Royal Technical College, Glasgow, at 7-30 p.m., when Sir Henry Fowler, K.B.E., will deliver his presidential address. Chairman, Mr. D. Keachie. Visitors will be welcome.

Tuesday, November 2nd : Meeting of the Wolverhampton branch, at the Talbot Hotel, Wolverhampton, at 7-30 p.m., when Mr. H. B. Benny will read a paper entitled "The Influence of the Detailed Design on the Cost of Production." Members of other Midland branches are invited.

Tuesday, November 2nd : Meeting of Coventry graduates' branch at 7-45 p.m., when Mr. R. V. Newton will read a paper on "Applied Time Study."

Thursday, November 4th : Private view day of the Motor Show at Olympia, by special invitation of the Society of Motor Manufacturers and Traders.

Wednesday, November 10th : General meeting of the main institution at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 8 p.m., when Mr. J. H. S. Dickenson will read a paper on "Some Notes on the Report of the Steel Research Committee." Card of invitation to the meeting may be obtained on application to the Secretary of the institution, 28, Victorian Street, London, S.W.1.

Wednesday, November 17th : Joint meeting of the Coventry and Birmingham graduates at the Chamber of Commerce, New Street, Birmingham, at 7-30 p.m., when a discussion on the Olympia Show will be held.

Thursday, November 18th Meeting of the London graduates at the offices of the Institution, 28, Victoria Street, London, S.W.1, at 8 p.m. Discussion on the Olympia Show.

Tuesday, November 30th : Meeting of the Coventry graduates' Branch at 7-45 p.m., when Lieut. H. J. Caper will read a paper entitled "Experience in the Field." Chairman, Major B. W Shilson

Reviews.

Debentures. By H. W. Jordan. London : Jordan & Sons Ltd., 116 and 117, Chancery Lane, W.C.2. 1s. 6d. net.

We note that this little book was first published in November, 1913, and that it is now in its ninth edition. No doubt it fulfils a useful purpose by explaining to those with little knowledge of finance the use of debenture, and the issue of debentures. It is essentially a primer very lucidly expressed.

The Fireman's Handbook. By C. F. Wade, A.M.I.Mech.E., A.M.I.E.E. London : Longman, Green & Co., Paternoster Row. 2s. 6d. net.

A handy little book of 80 pages. It is, as its name implies, a simple manual for stokers and furnacemen, and deals with the many problems which arise in handling boiler plant in a clear and practical way. There is a very great deal in efficient stoking, and a volume like this should assist young stokers and engineers very materially. It is divided into 14 chapters, and there are 20 new illustrations.

The Engineering Enquiry. By Tomey Thompson. Bristol : J. W. Arrowsmith Ltd., Quay Street.

This is quite a new type of reference book. It is intended for both the technical and non-technical man. It is described by the author as a pocket book for the practical assistance of agents, engineers, contractors, salesmen, etc., to enable them when ordering machinery to specify the exact particulars which will enable the manufacturer to quote. It is a frequent experience of engineering firms to be asked to tender for a machine or engine without being given the full requirements relative to the work that will have to be done. If such an enquiry comes from overseas, the firm has one of two courses open, viz., it may write for particulars, and this means a delay, or it may quote a "safe" price, and probably lose the contract. The prospective buyer, whether an engineer or not, can refer to the "Engineering Enquiry" and get all the data necessary to send to the manufacturer.

The idea of the book is unique and good, and if there are many omissions they will probably be filled in in future editions. Indeed, it is difficult to see how such a book can ever approach completeness, at least in the form of a pocket book, because the field covered is so large. There is a short section on industrial and technical data, explaining how to calculate horse power, temperatures, etc., which is good, and 20 pages comprise a directory of manufacturers and sellers which it would have been wiser to have left out.

Patent Protection. By Arthur Abbey, A.M.I.Mech.E. Manchester : John Heywood Ltd.

A brochure of some 30 pages, intended as a guide to draughtsmen, and forming one of the Association of Engineering and Shipbuilding Draughtsmens' technical series. It should prove valuable to the inventor who wants to know the first steps he should take to protect himself.

Gity and Guilds' Programme. By John Murray. London : 2s. 6d. net.

The programme of the Department of Technology of the City and Guilds of London Institute, which has just come to hand, does not differ materially from those of past years. It has been decided that in future in England and Wales examinations in grades lower than the final examinations shall not be held. This means that future candidates for final certificates need not have passed in a lower grade.

The October issue of the *Aeronautical Journal*, the official organ of the Royal Aeronautical Society, 7, Albemarle Street, W.1, contains an important paper on "Wire Rope," by Mr. Walter Scoble, which is of great interest to the engineering profession generally. During the war, Mr. Scoble was engaged at the East London College upon work for the Admiralty, in connection with the anchoring cables of kite balloons, and it is the result of these researches which is now published. The scope of the paper is of such a wide and general nature that it is of interest to all engineers who use cables for winding and driving work. The same number of the journal also contains an important paper by Mr. Harris Booth on "The Design of Spars with Off set Pin Joints."

Trade Items, Notes, &c.

James Caldwell, M.Inst.C.E., deputy chairman of Industrials Ltd., and technical director of several electric welding concerns, has retired from the firm of James E. Sayers & Caldwell, consulting engineers, Glasgow, as from August last. Address, 14/16, Cockspur Street, and Parliament Mansions, Victoria Street, London, S.W.1.

Institute of Metals.—The programme of the Institute of Metals and of its various local sections for the session 1920–1921 is an attractive one. The annual general meeting takes place on March 9th and 10th, 1921, at the Institute of Mechanical Engineers Rooms, Storeys Gate, S.W.1, and the May lecture will be delivered on May 4th, by Prof. T. Turner, M.Sc., A.R.S.M., also at the Institute of Mechanical Engineers Rooms. The meetings of the local sections of the Institute will, in future, be free to all members.

Wild-Barfield Electric Furnaces.—Messrs. Cross, Son & Robertshaw have been appointed sole selling agents for Wild-Barfield electric furnaces for the counties of Northumberland, Durham, Cumberland and Yorkshire. In addition to their office in Newcastle, Messrs. Cross, Son & Robertshaw have opened a branch office at 41, Great George Street, Leeds, where a demonstration furnace is in course of erection. Messrs. Macbeth Bros. & Co. Ltd., of Bombay and Calcutta, have taken over the sole selling rights for India, where these plants are already in operation.

Boilers.—Messrs. Holdsworth & Sons Ltd. have issued a new catalogue, which is profusely illustrated. Thirteen years have passed since the Yorkshire boiler was introduced, and in this catalogue are given comparative details of evaporation of Lancashire and Yorkshire boilers when working under identical conditions. In view of the scarcity and high price of fuel, useful notes and data are also included, and it is claimed if they are acted upon the effect will be to reduce fuel consumption in steam boilers by 10 per cent to 15 per cent.

The Austin Motor Position.—The chairman of the Austin Motor Co. has circulated to the company's shareholders the results of a certificated valuation recently made of its assets and liabilities. This valuation shows assets at £6,500,000 and liabilities at £1,700,000 odd, giving a net balance of £4,800,000. In a covering letter Sir Herbert Austin states that the company's business is progressing in a most gratifying manner, and that he hopes the shareholders will not allow the present state of the share market to affect their confidence in their investment in the shares. It is perhaps permissible to point out, however, that, especially in a time of slumping trade, a company's cash position is as important as its surplus of assets, which in this case may be presumed to be valued at the top of the market. Sir Herbert Austin, moreover, does not appear to err on the side of pessimism, for at the company's meeting held in June he vigorously combated the suggestion that the boom in the motor trade was over.

Solicitude for the Public.—A writer in a London morning paper suggests that exhibitors at the November motor shows at Olympia and the White City should not be allowed to exhibit unless they can guarantee delivery of cars say, within a period of four months. It is urged that persons who deposited cash at the last motor show at Olympia have received neither their deposits back nor the cars. To safeguard the public, therefore, it is proposed that guarantees be given that every firm exhibiting has actual works in full running order producing the goods exhibited, and can deliver them within four months. That would be very pretty of motor car makers could control the labour and raw material markets. The smell of the moulders strike is still in the nostrils of manufacturers, and they are held u peven now for a multitude of small castings, etc., for which mone yand time has to be spent abroad in pursuing a painful search. It is easy to make arm-chair suggestions such as these, but after all, there are practical difficulties in the way of British manufacturers of motor cars, which cannot be overcome by the stroke of a vigorous pen.

Gas Heating.—In everything the worker and his wife are determined to improve their conditions, but particularly in the home. The wife of the artisan to-day is no more willing to run her house with antiquated appliances than is her husband to work with inefficient tools or obsolete machinery. A paper on the subject of gas heating in relation to economy in building was recently read by a housing expert before the Society of Architects. This paper contained a vast amount of detailed information regarding the equipment of the houses which are being built under the Government's housing schemes. It has now been published and illustrated with useful drawings and plans, and should be of interest to every architect and builder, and anyone intimately concerned with housing problems who is anxious to be in close touch with present-day improvements. A copy of the report of this paper and the subsequent discussion is contained in the issue No. 81 of the monthly publication of "A Thousand and One Uses for Gas," and will, we understand, be posted to anyone interested, on application being made to the Secretary of The British Commercial Gas Association, 47, Victoria Street, S.W.1.

Engineering Trade Wages.—The National Federation of General Workers have forwarded to the engineering and shipbuilding employers and the controlled railways a claim for an advance of sixpence an hour for all time workers—men and women—with an equivalent percentage advance in piece-work prices, threepence an hour advance for boys and girls, and a claim for the consolidation of all war advances and bonuses. The demand applies to all members of unions affiliated to the Federation employed in engineering and shipbuilding and in railway shops. The claim will not on this occasion be heard by the Industrial Court. In accordance with a decision reached on September 15 the Federation is asking that negotiations shall take place direct with the employers. The Federation of Engineering and Shipbuilding Trades and the Amalgamated Engineering Unions have made similar claims A million and a half workers are involved. For the engineering employers it was stated recently that no date had been fixed for a conference. The shipbuilding employers were to meet the unions on October 22nd.

Armstrong, Whitworth & Co's Report.—The directors of Sir W. G. Armstrong, Whitworth & Co. have issued their report and accounts for the four years ended December 31st, 1919. The profit and loss account shows that the net profits for the whole period amounted to £4,053,605. From this is deducted £1,000,000 for further writing down of capital expenditure, and £2,465,093 dividends paid for the four years, including the final distribution for 1919, leaving £588,512, which, with the balance of £461,387 brought from 1915, gives a sum of £1,049,899 to be carried forward. The report states that owing to the extent and complexity of the work undertaken during the war it has been impossible to separate the accounts, and the four years are therefore submitted as one period. Since the publication of the last report the Siddeley Deasy Motor Car Co. has been acquired, and a controlling interest taken in Pearson & Knowles Coal and Iron Co., Armstrongs and Main and Crompton & Co. The reorganisation of the works for peace industries is now complete, and much commercial work has been undertaken. But until the general conditions of manufacture become more stable it is difficult to make any forecast of the future.

The Growing Use of Coke.—Increased railway rates are resulting in a diversion to our highways of an ever-increasing volume of long-distance goods traffic. Owing to the relatively high price and growing scarcity of fuel for petrol motors, the steam wagon, especially the coke-fired variety, maintains its superiority for heavy haulage. Mr. E. W. L. Nicol, A.I.E.E., M.I.Mar.E., in a new illustrated publication entitled "Coke and Its Uses," states that thousands of these coke-fired vehicles are at present running in this country, and that their number is rapidly increasing. That the use of coke instead of liquid fuel is economically sound he has no doubt, for, as Sir George Beilby, F.R.S., Director of Fuel Research, pointed out recently, coal is now and is likely to remain the world's principal source of fuel While the world's output of coal is roughtly 1,500 million tons per annum, the output of petroleum is about 75 million tons. In this country, the natural source of heat and power is coal, and unless and until it is proved that oil exists here in very large quantities we have no alternative but to concentrate our best energies on the adaptation of the products of coal to the purposes of transport by sea and land In addition to the article dealing with transportation matters, there is also one on "Coke in Relation to Cheap Power." Practical methods are indicated by means of which the efficiency of existing steam boilers may be increased. The booklet is one which should be read by all users of steam for power or for road transport, and can be obtained on application from the Secretary, The British Commercial Gas Association, 47, Victoria Street, S.W.1.

Foreign Notes.

French Submarine Construction for 1921.—The Ministry of Marine contemplates the construction of six submarines of 1,100 tons each in 1921, four to be constructed at Cherbourg, and the other two at Toulon.—Reuter.

River Harbour Works at Bale.—The Federal Council has proposed to the Federal Assembly that a fresh subsidy of Fr.500,000 should be granted for river harbour works at Bale.—Reuter.

German Locomotives for Soviet Russia.—The *Kasseler Neueste Nachrichten* reports that the Locomotivfabrik Henschel und Sohn, Kassel, are building 200 locomotives for the Soviet Government.—Reuter.

State Iron and Steel Works in Queensland.—The Hon. Mr. A. J. Jones, Secretary for Mines, announces that he is hopeful that developments now in progress will enable the Government to proceed with the construction of the State iron and steel works at Bowen.—Reuter.

Water Power in Canada.—Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission, states that along the waterways between Sault Ste. Mario and Montreal it should be possible to develop some 4,500,000 H.P. for Canadian use, having the same annual value as 90,000,000 tons of coal.

German Locomotives for Russia.—The *Dagens Nyheter* learns that the Bolshevik representative, Professor Lomonosov, has returned to Stockholm after a visit to Berlin, where he made a contract with the Locomotive Manufacturers' Trust for the delivery of 1,500 locomotives within one year.—Reuter.

Manufacture of Galvanised Iron Wire in Australia.—The Postmaster-General's Department, Melbourne, which is anxious to see the manufacture of galvanised iron wire established in Australia, is prepared to order immediately 350 tons of such wire of various gauges at attractive prices.—Reuter.

New Japanese Submarine School.—Admiral Imaizumi, the head of the new Submarine School, Tokio, states that Japan is building a number of submarines, and that a school for the exclusive training of officers and men has become necessary. Pending the construction of a special building, the school is using the battleship Shikishima.—Reuter.

Manitoba Rolling Mills Co.—The Manitoba Rolling Mills Co. Ltd. recently opened their steel furnaces, which have a capacity of 60 to 90 tons of steel ingots per day. The furnaces are operated with pulverised coal, automatically blown in; it is understood that this is the first time pulverised coal has been used in Canada for such a purpose.—Reuter.

New Belgian Tractor Co.—A new company, to be known as the Auto-Traction, has been established at Antwerp for the manufacture and sale of motor tractors. The company will exploit especially the Leytens patents. The capital is fixed at Fc.2,000,000 in 4,000 shares of Fc.500 each, and there are also 500 dividend shares of no nominal value.—Reuter.

New Australian Company to Manufacture Electrical Equipment.—A new company is being formed at Melbourne under the title of the Commonwealth Electric and Metal Co., with a capital of £500,000, to establish works at Newcastle for the purpose of producing electrical equipment, metallic alloys and various other metal manufactures.—Reuter.

Canadian Pacific Contract for New Steamer.—The Canadian Pacific Ocean Services have awarded a contract to the Wallace Shipyards at Vancouver, British Columbia, for a new passenger steamer for the coast service. The vessel, which will cost 1,500,000 dols., will be 325 feet long, with a speed of 17 knots, and will be built specially for the Alaska run.—Reuter.

New Spanish Shipbuilding Yards. Don Juan Pla Rusiñol has been authorised to establish yards for the construction of vessels of medium tonnage in the bay of Cadiz, between the Viniegra-Valdés mole and the Madrid road. Authorisation has also been granted to Don Francisco Cardama Godoy to construct yards for the building of smaller boats on the Coya bank of the River Vigo. Reuter.

New Apparatus for the Control of Fuel Consumption.—The Swedish engineer, Mr. Olaf Rodhe, who belongs to Svenska Aktiebolaget Mono, Stockholm, has invented in co-operation with the above company's constructors, a new apparatus designed for the control of the consumption of fuel for steam boilers. The new apparatus is named Duplex Mono, and the result of experiments shows that by its use the consumption of fuel is reduced by 10 to 20 per cent.—Reuter.

State Iron and Steel Works in Queensland.—The Hon. Mr. E. G. Theodore, Premier of Queensland, in the course of a recent speech, announced that the Federal Government would not abandon the plans for the State iron and steelworks, even if the response to the local loan was unsatisfactory. Engineering firms of repute in England had sounded the Government as regards supplying and erecting the necessary machinery and financing the whole project.—Reuter.

Machinery and Mill Stores in India.—Enquiries and orders for machinery of various kinds are being sent by every mail. There is a tendency for inquiries to go to America first. The demand is so great that no one country can hope to supply the whole of it. The animation of the mill stores market has subsided, and the market has become steady. Cotton healds are still in demand. Roller cloth, roller skins, pickers and picking bands have a poor demand. The quotations are at recent prices.—Reuter.

Water Power Project in California.—The Mount Shasta Power Co., a corporation owned by the Pacific Gas and Electric Co., has applied to the State Railroad Commission for authority to make expenditures aggregating 125,000,000 dols. for the development of hydro-electric power. The plan of the company is to instal a plant with 515,000 H.P. at one point in the mountains and to conserve the streams in other areas to develop 7,000,000 kilowatt hours a day. This will virtually double the power output of the plants operated by the Pacific Gas and Electric Co. The use of hydro-electric power will save this corporation 35,000 barrels of oil a day. Five new power houses are to be constructed, and a seven-mile concrete tunnel will have to be built.—Reuter.

Agricultural Machinery Exhibition in Rome.—The formal inauguration of the first International Exhibition of Agricultural Machinery, organised by the Italian Agriculturists' Society, took place recently. The Minister of Agriculture, the President of the Agriculturists' Society, the Mayor and Prefect of Rome were present, as were also the diplomatic and commercial representatives of Great Britain, France, the United States, Austria, Germany, and Czecho-Slovakia, these countries sending a number of machines to the exhibition. Various directors of large agricultural establishments in Italy and abroad attended the ceremony. The President of the Society of Agriculturists and the Minister of Agriculture made speeches, which were received with great enthusiasm. An official tour was then made of the exhibition.—Reuter.

Rheinisch-Westfaelische Elektrizitaetswerke: Interesting Developments.—According to tho *Berliner Tageblatt*, very far-reaching developments are contemplated by the Rheinisch-Westfaelische Elektrizitaetwerke, the big enterprise founded by Herr Hugo Stinnes, which already supplies a large part of the Rhenish-Westphalian industrial area with electricity. The plan provides for extension in two directions. On the one hand the company proposes to extend the area which it supplies with current by combination with other great central works in the industrial area, and specially with the Elektrizitaetswerk Westfalen Aktien-Gesellschaft, with the avowed object of ultimately bringing the electrical supply of the entire Ruhr basin under one control. Even more interesting developments in the other direction have as their object the changing of the main fuel basis of the whole concern from coal to lignite. This object is to be attained through tho working agreement which has been come to with the Braunkohlenwerk Roddergrube. This agreement provides for the complete taking over of the Roddergrube concern at a later date. The reasons for the change from coal to lignite are apparently, in the first place, the endeavour to reduce the domestic consumption of coal for all purposes for which other fuels are available in view of the quantities of coal to be delivered to the Allies under the Peace Treaty, and, secondly, the greater economy of lignite fuel for generating electricity.—Reuter.

New Companies.

Jackson Asbestos Manufacturing Co. Ltd.—Private company. Registered Sept. 10th. Capital £2,500 in £1 shares. To carry on the business of mine owners, manufacturers, exporters and importers of and dealers in hardened or other asbestos, etc. The first directors are: J. Adler, A. Levinson, and A. E. Gilbert. Registered office: Asbestos Works, Jenkins Street, Birmingham.

Staffordshire Spring Co. Ltd.—Private company. Registered Sept. 8th. Capital £5,000 in £1 shares. To take over the business of a manufacturer of and dealer in springs carried on by A. Spencer at Hill Top, West Bromwich, Birmingham, as the "Staffordshire Spring Co." The first directors are: G. P. Jewell, B. Bates, and J. W. Taylor. Registered office: 33, Hill Top, West Bromwich.

Bar Fittings Ltd.—Private company. Registered Sept. 22nd. Capital £1,000 in £1 shares. To carry on the business of painters and decorators, furnishing and general ironmongers, metal and woodworkers, shop and bar fitters, general providers of shop, bar, office and household fittings and furnishing requisites, etc. The first directors are: W. Foster, G. C. Knight, and F. Haylock. Qualification: 1 share. Solicitor: A. F. Fraser, 6, Sherwood Rise, Nottingham.

Geo. Hollins & Sons Ltd.—Private company. Registered Sept. 21st. Capital £25,000 in £1 shares. To carry on the business of ironmongers, builders' and plumbers' merchants, glaziers, painters, decorators, engineers, founders, manufacturers of and dealers in iron, steel, bricks, tiles, pipes, pottery, earthenware, china and terra cotta goods, chalk, clay, gravel, sand, cement and other building materials, oils, colours, glass and other painters', glaziers' and decorators' materials, barrels, timber, hardware, etc. The first directors are: E. M. Hollins, H. Hollins, G. Hollins, W. L. Dixon, and A. J. Skitt. The two first named are life directors. Solicitor: H. E. Moody, Tunstall, Staffs.

J. Rhodes & Co. Ltd.—Private company. Registered Sept. 21st. Capital £5,000 in £1 shares. To take over the business of engineers carried on at 168, Staincliffe Road, Dewsbury, as "J. Rhodes & Co." The first directors are: G. B. Hartley and J. Rhodes. Secretary: G. B. Hartley. Registered office: 26, Market Street, Cleckheaton.

D.C.M. Tap Co. Ltd.—Private company. Registered Sept. 7th. £5 000 in £1 shares. As title. Directors: J. McFarlane, D. Cleland, H. Wood, H. McLachlan, and E. Hudson. Registered office: 177, West Regent Street, Glasgow.

Erecta Ltd.—Private company. Registered Sept. 23rd. Capital £10,000 in 8,000 preferred shares of £1 each and 40,000 ordinary shares of 1s. each. To manufacture and deal in fire-extinguishing apparatus, etc. The first directors are: A. Jonckheere, C. C. O. Whiteley, N. P. Jonckheere, F. H. Reeder, H. Taylor, and J. A. Taylor. Secretary (*pro tem.*): G. W. Nicholls. Registered office: Brownlow House, 50 and 51, High Holborn, W.C.

Petrel Engineering Co. Ltd.—Private company. Registered September 22nd. Capital £5,000 in £1 shares. To take over the business carried on at 26, Sea Street South, Birmingham, as the "Petrel Engineering Co.," to carry on the business of manufacturers of and dealers in cycles, motor cycle, and motor car accessories, etc., and to adopt an agreement with J. Cooke and J. Vandenberg. The first directors are: J. Cooke, J. Vandenberg, C. M. Powell, F. Powell, and F. J. Urry (chairman). Qualification: £100. Registered office: 26, Rea Street South, Birmingham.

Dickin Bros. Ltd.—Private company. Registered September 22nd. Capital £25,000 in £1 shares. To take over the business of a coal, coke, pig-iron, and iron-ore merchant, carried on by G. H. Dickin, at Monument Lane, Birmingham, as "Dickin Bros." G. H. Dickin is permanent governing director and chairman. Solicitor: A. D. Brooks, 37, Waterloo Street, Birmingham.

John Lang & Sons (Blackburn) Ltd.—Private company. Registered September 23rd. Capital £8,000 in £1 shares. To take over the business of ironfounders carried on at the Blakewater Foundry, George Street West, Blackburn, as "John Lang & Sons," and to adopt an agreement with J. Lang and W. Lang. The first directors are: J. Lang, W. Lang, J. Cort, and A. A. Manning. Registered office: Blakewater Foundry, George Street West, Blackburn.

John G. Scott Ltd.—Private company. Registered in Edinburgh September 14th. Capital £15 000 in £1 shares. To carry on the business of iron, steel and hardware merchants, etc. The first directors are: J. G. Scott, T. M. Scott and J. G. G. Scott. Registered office: 42, Frederick Street, Edinburgh.

Mortgages, Charges, Satisfactions.

Chamberlin & Hill Ltd.—Satisfaction to the extent of £5,000, on October 1st, 1920, of mortgage debentures, dated April 8th, 1903, securing £10,000.

Dyffryn Works Ltd.—Debenture, dated September 29th, 1920, to secure all moneys due or to become due from company to Barclay's Bank Ltd.,, charged on the company's undertaking and property, present and future, including uncalled capital.

Rhymney Iron Co. Ltd.—Satisfaction in full on August 12th, 1920, of mortgage dated August 11th, 1914, securing all moneys due or to become due.

Kitson Empire Lighting Co. Ltd.—Satisfaction in full on August 19th, 1919, of first mortgage debenture, dated August 21st, 1914, securing £5,000.

Glamorgan Wagon Co. Ltd.—Satisfaction in full on October 8th, 1920, of debentures dated October 17th, 1917, securing £350.

H. & J. Quick Ltd.—Particulars of £7,000 debentures authorised October 2nd, 1920; present issue £3,000; charged on the company's property, present and future, including uncalled capital.

Gloucester Railway Carriage and Wagon Co. Ltd.—Issue on October 11th, 1920, of £850 debentures, part of a series already registered.

R. J. Ward, 10, Serjeant's Inn, E.C., appointed interim receiver over October 15, by order of Court dated October 6th, 1920.

Samuel Butler & Co. Ltd.—Mortgage dated October 2nd, 1920, to secure all moneys due or to become due from company to National Provincial and Union Bank of England Ltd., charged on certain lands and buildings in Stanningley, Leeds.

Repetition Engineering Co. Ltd.—Debenture dated September 24th, 1920, to secure £800 charged on company's undertaking and property, including uncalled capital. Holder, Mrs. W. D. Wagg, 53, Cedar Road, Sherwood Rise, Nottingham.

T. W. Field Engineering Co. Ltd.—W. S. Berry, 60, Spring Gardens, Manchester, ceased to act as receiver or manager on July 7th, 1920.

E. A. Gardner & Sons Ltd.—Satisfaction in full on June 25th, 1920, of mortgage dated October 26th, 1918, and securing £2,500.

Tranmere Engineering Co. Ltd.—Debenture dated September 29th, 1920, to secure £700, charged on the company's undertaking and property, present and future, including uncalled capital, subject to prior charges. Holder, S. F. Grandidge, 27, Park Road South, Birkenhead.

Henry Durke Ltd.—Particulars of £15,000 debentures, August 30th, 1920; whole amount issued; charged on the company's undertaking and property, present and future, including uncalled capital.

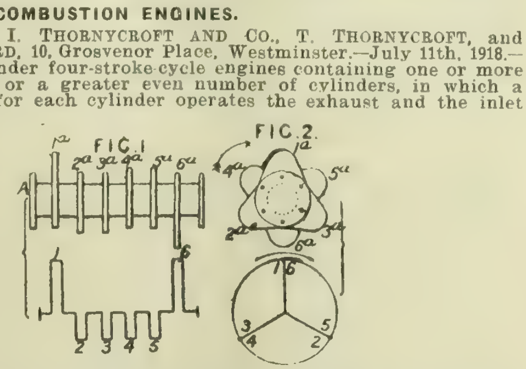
Patent Applications.

ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

132,304.—J. I. Thornycroft and Co., T. Thornycroft, and V. G. Barford, 10, Grosvenor Place, Westminster.—July 11th, 1918.—In multicylinder four-stroke-cycle engines containing one or more units of six or a greater even number of cylinders, in which a single cam for each cylinder operates the exhaust and the inlet

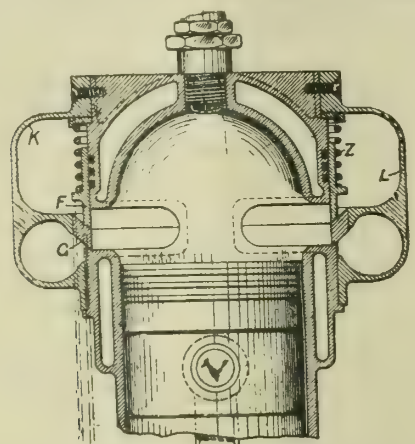


valve, the construction is simplified by making use of one pattern of cam-shaft unit for each cylinder unit adapted to be driven from either end according to its position in the engine. For this purpose the successive cams counting from the left-hand end of a cam-shaft unit are set at 180 degrees to the corresponding cams counting from the right-hand end, and the spacing of the

cams along the shaft is similar from either end. In accordance with this arrangement, the cams on the right and on the left of the centre of the cam-shaft may, in some cases, be similarly arranged, but set clockwise with one another and anti-clockwise respectively on the two portions of the shaft. In Figs. 1 and 2, the setting of the cranks of a six-cylinder unit is shown at 1, 2, 3, 4, 5, and 6, and the setting of the cams 1*a*, 2*a*, 3*a*, 4*a*, 5*a*, and 6*a*. The cylinders fire in the order 1, 4, 2, 6, 3, 5, the crank-shaft rotating in the direction shown by the arrow. Looking from the end A, the cams 1*a*, 2*a*, 3*a* are arranged anti-clockwise and the cams 4*a*, 5*a*, 6*a* are arranged similarly but clockwise. The two ends of the cam-shaft unit and also the driving means are provided with coupling-flanges with suitably-spaced holes, *e.g.*, spaced hexagonally, or suitably keyed sleeves or clutches may be employed, whereby two or more cam-shaft units may be connected together or to the driving-means in a definite angular position. Arrangements are described for twelve cylinders in line, and for two sets of twelve cylinders in line inclined at 90 degrees to one another.

INTERNAL-COMBUSTION ENGINES.

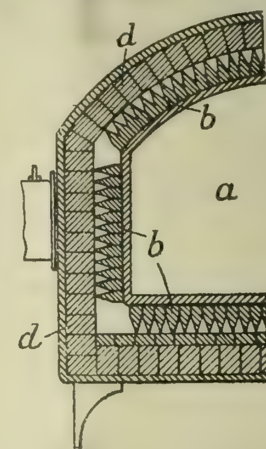
132,159.—F. H. HARRIS, 36, Albert Drive, Low Fell, Gateshead-on-Tyne.—Jan. 25th, 1919.—Co-axial ring or sleeve valves F, G, closing against seatings at their lower edges are arranged outside



the combustion chamber walls so that they can be removed upwards in dismantling, and the valves are enclosed by cover-plates K, L which may be integral with one another, and contain the inlet and exhaust passages. The valve-closing spring Z also surrounds the combustion chamber and is removable with the valves. The combustion head may be water-cooled, and if not integral with the water-cooled cylinder, it may be secured thereto by hollow bolts.

ELECTRIC FURNACES.

132,635.—T. A. D. LAWTON, Essington House, Wolverhampton, and J. HAMPTON, The Elms, Wrotsley Road, Tettenhall, both in Staffordshire.—Sept. 28th, 1918.—Resistance bars *b* of graphite or the like are shaped so as to present a large surface to a heating-chamber *a* and a small surface to a refractory enclosure *d*. The sides of the bars may be in contact and the current passed across



them, in which case they are so proportioned that the increase of pressure due to expansion compensates the temperature coefficient of resistance of the material; or the bars may be spaced and connected in a grid, the current being longitudinal. The enclosure is as nearly as possible air-tight.

ELECTRIC FURNACES.

132,616.—J. BIBBY and J. O. BOVING, 56, Kingsway, London.—Sept. 20th, 1918.—In a blast furnace heated by current passed through the charge, the curent is supplied by three single-phase transformers or one three-phase transformer, the middle points of the secondary windings being interconnected so as to maintain a constant tension between any pair of electrodes. The electrodes may be arranged at the corners of a hexagon, the two ends of each secondary being connected to opposite electrodes.

INDEX TO ADVERTISERS.

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CONTENTS.

EDITORIAL.

APPRENTICESHIP.

APPRENTICESHIP and training are not synonymous terms. The practice indeed of making boys serve a number of years to a trade and shutting out older men, who by inclination or special ability would make excellent craftsmen, is a relic of days before present-day industrialism was even thought of. It has persisted in all industries, but it has been found necessary to modify or relax restrictions in some, which, by their rapid development, absorbed large numbers of untrained and unapprenticed men. During the war period this position prevailed in the engineering workshop, because of the urgent need for munitions, a large number of men who were termed "dilutees" entered the workshops after a period of intensified training, and in many cases proved themselves so adaptable that they soon acquired greater skill than others who had served a regular apprenticeship, and had the value of long, practical experience. The fact is that industries are so much sub-divided at the present day, that youths spend a period of years presumably being trained to perform one or two operations, but which is largely a waiting period. Industrialism appears to be entering on a new era, and the old system of apprenticeship will have to go. It is not good for either employers or workmen that the choice of entrants to a trade should be limited, because it keeps down the average level of capacity, and the more highly-trained and perfectly organised a trade or industry is, the better is it capable of meeting and beating foreign competition. The old doctrine of vested interests, as it is called by the economists, must go, and trade unionists are adopting a suicidal policy if they wish to retain it.

The agreement which has been reached by employers and men in the Scottish ironfoundry trade, whereby the apprenticeship period will be reduced from seven years to five years is welcome, but this is not enough. This modification has been made necessary in order to attract lads to the foundries. The proportion of apprentices to journeymen is stated to be one in nine, and the shortage of moulders is having a serious effect on the whole engineering industry. But the agreement does not go far enough. The founder's craft is one in which high skill can only be acquired after much endeavour, but many ex-soldiers would soon acquire skill. The objection is presumably the same as that of the building trade operatives; apart from the unconscious application of the doctrine of vested interests, there is the fear that dilution would undermine protective organisation and sweep away the system of collective bargaining. There could be no greater fallacy than this.

It is difficult to believe that Mr. Chadwick, chairman of the National Union of Foundry Workers, is only thinking of the status of the industry when he condemns the entrance of ex-service men because no intensified training will make a practical moulder. It is for any industry as a whole, with due regard to the national welfare, to decide the method and period of training that is necessary for the attainment of a reasonably high degree of skill.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page* 11, *October 22nd.*)

Callendar's Researches.

We are indebted to Professor Callendar for placing resistance thermometry on a sound and accurate basis. From the Cavendish Laboratory, Cambridge, he published, in the *Transactions of the Royal Society* of 1887, the first of his elaborate experiments "On the Practical Measurement of Temperature." His idea was that a wire of pure platinum had the necessary qualifications for a standard electrical resistance thermometer, and he introduced the term *platinum temperature*. To explain this let :—

R_0 be the resistance of a wire at 0° C.
R_{100} be the resistance of a wire at 100° C.
R_t be the resistance of a wire at t° C.

then an increase of resistance of $R_{100}-R_0$ corresponds to a rise of 100 deg., and an increase per ohm. corresponds to a rise of $\frac{100}{R_{100}-R_0}$, therefore an increase of $R_t - R_0$ corresponds to a rise of

$$\frac{(R_t - R_0)\,100}{R_{100}-R_0} \text{ deg.}$$

if a law of simple proportion be followed. This last value he denoted by *pt.*, an abbreviation for platinum temperature. The increase $R_{100}-R_0$ is called the "fundamental interval" or F.I., hence

$$pt = \frac{(R_t - R_0)\,100}{\text{F.I.}}$$

He found that the platinum temperature and the true temperature t, as given by a gas thermometer, are connected by the equation :—

$$t - pt = \delta\left(\frac{t^2}{100^2} - \frac{t}{100}\right)$$

where

$$\delta = \frac{10{,}000\,\beta}{\alpha + 100\,\beta}$$

to an accuracy of one per cent through a range of 600°C. The value of δ was found to be 1·57 for a particular sample of platinum wire.

Callendar's formula renders calculations of the true temperature from the platinum temperature much easier than by the use of the α and β coefficients. The values can be arranged in a table such as shown below :—

$\delta = 1·5$

pt° C.		t° C.		Difference for 1° pt.
0	..	0	..	0·985
50	..	49·625	..	1·000
100	..	100	..	1·015
200	..	203·14	..	1·048
300	..	309·75	..	1·084
500	..	534·89	..	1·170
800	..	910·76	..	1·347
1000	..	1196·95	..	1·524

Construction of Callendar's Thermometers.

The coils of platinum wire used by Callendar in his original experiments were made of pure metal having the high temperature coefficient of 0·00346, instead of 0·003, which is the value for the commercial wire. After being kept at 1200° C. for two hours, its resistance had not changed by 0·02 per cent, when retested at freezing point. About a metre of wire, having a diameter of 0·07 mm., with a resistance of about 5 ohms, was used to construct a thermometer. Connecting leads of thicker platinum wire were fused on by the help of a oxy-hydrogen blowpipe, and then the thermometer coil was thoroughly annealed by heating in a bunsen flame. After many experiments the method of insulating finally adopted is shown in Fig. 16. The wire is wound on a serrated mica frame, and the leads are insulated by passing them through small holes in mica discs. There are four leads, two from the ends of the coil terminating in terminals marked P and P, whilst the other two are compensating leads which are connected to the terminals

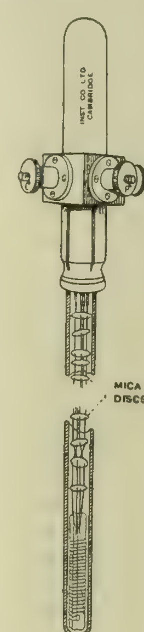


Fig. 16.

C and C. The latter are connected in short circuit and are used to balance the resistance of the thermometer leads, as will be better understood later. According to the temperature to be measured a containing tube of glass or porcelain is used.

Standarisation of Thermometers.—The Callendar formula (already stated) :—

$$t - pt = \delta^2\left(\frac{t^2}{100^2} - \frac{t}{100}\right)$$

is derived from the formulæ :—

$$R_t = R_0\,(1 + \alpha t + \beta t^2)$$
$$R_{100} = R_0\,(1 + \alpha\,100 + \beta 100^2)$$

from which we obtain :—

$$\frac{R_t - R_0}{R_{100} - R_0} = \frac{t\,(\alpha + \beta t)}{100\,(\alpha + \beta 100)}$$

Now :

$$pt = \frac{R_t - R_0}{R_{100} - R_0} \times 100 = \frac{t\,(\alpha + \beta t)}{\alpha + \beta 100}$$

and

$$\frac{pt - t}{t} = \frac{\beta\,(t - 100)}{\alpha + \beta 100}$$

Let $\beta\ \alpha = -\delta \times 10^{-4}$ nearly, then

$$t - pt = t\frac{\delta}{10^4} \cdot \frac{t - 100}{1 - \delta/100}$$

$= \delta\left(\frac{t^2}{100^2} - \frac{t}{100}\right)$ approximately, which is the expression derived by Callendar.

It depends on the ratio between the two coefficients being nearly constant.

To test the accuracy of the formula, Heycock and Neville, in 1895, obtained the freezing point of gold with five different thermometers. Their results are given below :—

Thermometer.	*pt.*	δ.	*t–pt.*	*t.*
13	908·7	1·500	153·2	1061·9
15	852·9	2·040	208·3	1061·2
18	900·7	1·574	180·7	1061·4
13A	905·3	1·563	158·6	1061·9
14	907·7	1·611	154·3	1062·0

This table shows the remarkable fact that in spite of the great variation of δ, yet the calculated temperatures agree within one degree in 1060° C.

Hence, once the value of δ has been ascertained, accurate temperature measurements are possible.

(*To be continued.*)

THE TIN MINING INDUSTRY.

In view of the prominent place which tin occupies to-day, partly as the result of the Cornish situation, a timely leader upon the subject of "Tin Supplies and Possibilities," appearing in the current issue of *The Metal World*, is of general interest. The article, which quotes Mr. Frank Merricks, C.B.E., states that about one-half of the world's supplies of tin are mined in the British Empire. Since 1891 the chief tin-producing country has been the Federated Malay States. The other tin-producing countries of the Empire are : Cornwall, Nigeria, Australia, and South Africa. Of foreign producers, Bolivia, the islands of Banca and Billiton in the Netherlands, East Indies, Siam, and China are the chief.

Previous to 1891 the tin output of the Empire was confined to Australia, British Malaya, and Cornwall, the value of the Australian production being £9,879,539, while that of British Malaya was estimated at £5,400,000. The value of the Nigerian output, however, is now becoming important, and to-day exceeds that of Australia. At the same time the output of tin in British Malaya has fallen during the last few years, and in 1919 amounted to only 36,867 tons, as against nearly 50,000 tons in 1914. Simultaneously tin production in Bolivia, Siam and China has increased, so that the proportion of the world's tin supplies produced in the British Empire latterly shows a decrease. Singapore possesses the largest tin-smelting plant in the world, this belonging to the Straits Trading Co. Here most of the tin mined in British Malaya is refined, as well as ore shipped to Singapore from Siam, the Netherlands, East Indies, South Africa, and Australia. Consequently, the export of tin from Singapore is much greater than the actual production of British Malaya.

Although the existence of tin in Nigeria was known to Europeans as far back as 1885, it was not until 1903 that an official mineral survey was undertaken, while tin mining was started in 1906, and the first exports of tin concentrates were made in 1907. From this date the tin industry developed rapidly, and in 1918 there were 82 tin-mining companies operating in the northern provinces of Nigeria. The highest recorded export tonnage for any one year was in 1917, when 9,966 long tons of ore were exported. Tasmania is the largest producer of tin in the Australian fields, with New South Wales and Queensland next in order. In New South Wales a large proportion of the output is secured by dredging operations.

Bolivia, the second largest tin-producing country in the world, before the war sent part of her tin concentrate for smelting to Germany and part to the United Kingdom. In 1919, however, over 27,000 tons of tin ore were imported into Great Britain from South America, whose normal average output is about 23,000 tons. Other foreign tin-producing countries where an increase in output is taking place are : Siam with 8,300 tons yearly (smelted in Singapore), and China, whose chief centre of production of crude tin furnishes supplies to Hong Kong, where refining takes place.

Electric Power from Belgium for Italy.—A proposal to transmit electric power a distance of 750 miles has just been made by an Italian engineer, Professor Guarini. He suggests that instead of sending Belgian coal to Italy by railway, it should be possible to transform it into electric power, and transmit this power direct to Italy. He does not think that the plan presents any insurmountable difficulties. The distance, as the bird flies, between the Belgian mining centres and Lombardy, for instance, does not exceed 750 miles. He points out that such a scheme has already been found to be workable in South Africa, where a British company, utilising the power supplied by the Victoria Falls, transmits this 750 miles, with a loss of 25 per cent of the power.—Reuter.

French and German Machines Preferred.—Our enquiry department last week received a request from a London firm of merchants and exporters for names of makers of several wood-working machines. In the course of their letter, they say :—"Perhaps you can put us in touch with a French or German firm, as it would be undoubtedly better to obtain these machines from either of those countries at the present time, in view of the favourable rate of exchange. The machines are required for the South African market, and the prices will have to compete with those from America." What is the remedy for this state of things? In the early days of the war we were writing and talking about capturing enemy trade; and now, as a result of the war, and the consequent rise in prices, we are asked to assist in playing into German hands.—*Machinery Market.*

Industrial Lighting.—The General Electric Co.'s new catalogue should be of value to all factory and workshop owners. The necessity of good lighting in premises devoted to industry is becoming generally recognised. This is evident from the references to the subject in reports of the Home Office in England, and from the activities of similar authorities in other countries. In the United States, for example, codes specifying the minimum amount of illumination permissible for various operations have been adopted by certain States. Good lighting makes for increased efficiency directly by promoting greater production and also by reducing the percentage of spoiled work, and indirectly by safeguarding the health and eyesight of the workers, by minimising the risk of accidents, and by creating a bright and cheerful atmosphere in the factory. This catalogue, in addition to giving representative designs of industrial fittings suited for most situations met with in modern illuminating engineering practice, contains a valuable collection of illuminating engineering data, together with simple instructions for planning lighting schemes.

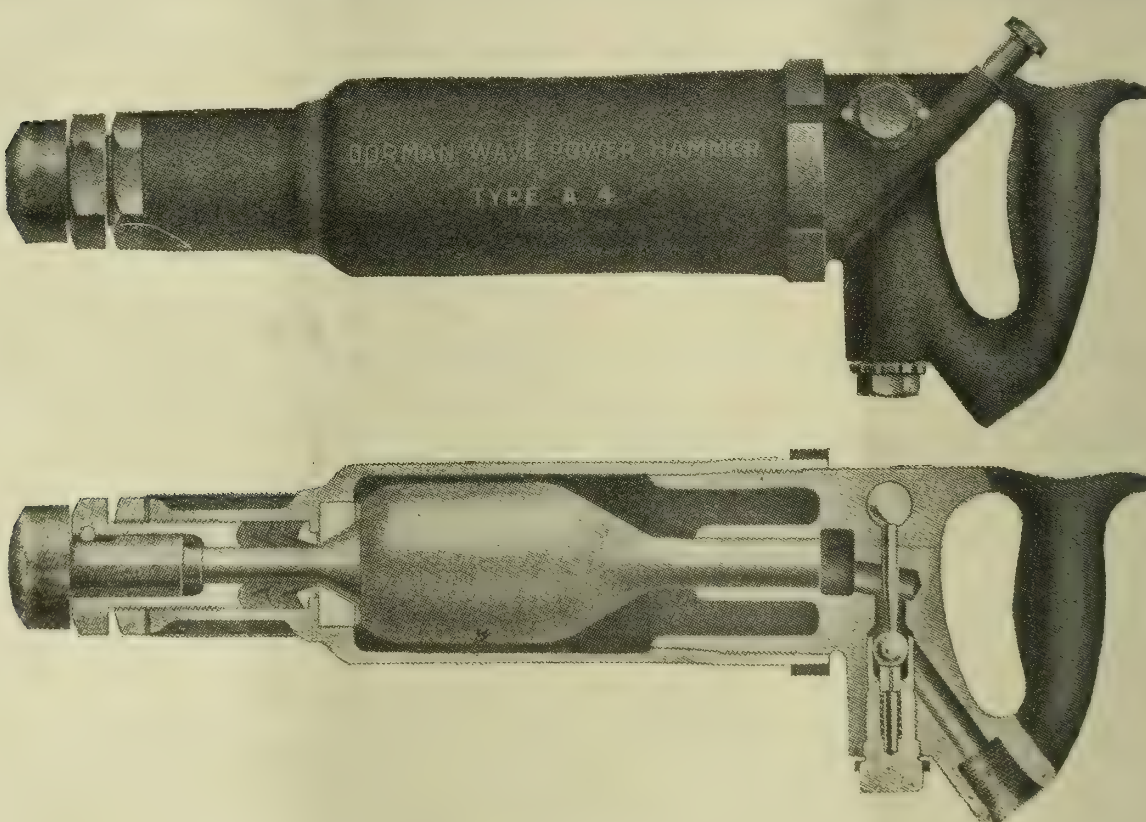
POWER TRANSMISSION BY WAVE MOTION.

The transmission of power has until now been conferred to five methods, namely, steam, electric, hydraulic, compressed air and direct mechanical, and it may well be that the invention of Mr. G. Constantinesco will mark the beginning of a new era in engineering. This sixth method is the transmission of energy through liquid, and the storage of energy in liquids. It has been called wave or sonic transmission, and wave motion or pulsation set up in an enclosed column of liquid are employed. It differs in principle from hydraulic transmission, because in hydraulics a continuous flow of liquid or motion of the liquid column as a whole invariably occurs, whereas in wave transmission there need be no direct or continuous flow, the particles of the liquid merely pulsating backwards and forwards about a mean position.

Water is only slightly compressible, but advantage is taken of this slight compressibility or elasticity to transmit energy. Let it be assumed that we have 150 metres of wrought-iron steam pipe, of 2·5 cm. diameter and 0·5 cm. thickness of metal, closed at one end and filled with water, and suppose a fluid-tight piston is forced into the pipe under a steady pressure of 35 kg. per square centimetre. If the liquid were incompressible the increase in volume of the containing pipe under the pressure would allow the piston to enter about 1·5 cm. If the pipe were absolutely inexpansible the pressure would compress the water to an extent that would allow the piston to enter about 26 cm. It is seen, therefore, that the compression of the water in a wrought-iron steam pipe of the size considered is the chief factor in the changes of volume which take place under pressure, and that the expansion of the containing pipe is almost negligible.

Application of Principles.

Imagine two cylinders fitted with plungers, the cylinders on the underside of the plungers being connected together by a long pipe completely filled with water. If one of the plungers is moved rapidly up and down it will set up at each downward stroke waves of compressed water, which, travelling along the pipe at the speed of sound (about 4,800 ft. per second) will exert their energy on the plunger at the far end, and if this be suitably loaded, a simple reciprocating motion will be produced in exact synchronism with the reciprocations of the first plunger. This is wave motion in its simplest form, and it was adapted in a very striking way during the war. Messrs. W. H. Dorman & Co. Ltd., of Stafford, who hold a licence from the patentee, made "interrupter" gears for firing a machine gun in aeroplanes with such precision that 2,000 bullets a minute could be sent between the blades of the revolving propeller. By this device, airmen were able to fire straight ahead, instead of having to manœuvre sideways, or adjust their aim for a gun placed overhead, and the result was that the once famous Fokker of the Hun was conquered.



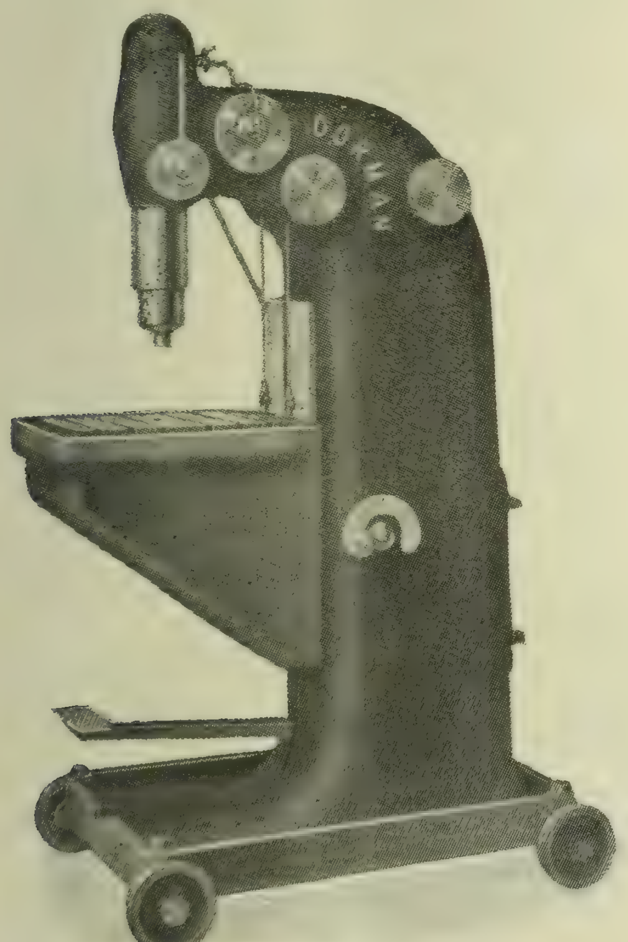
Riveting Hammer.

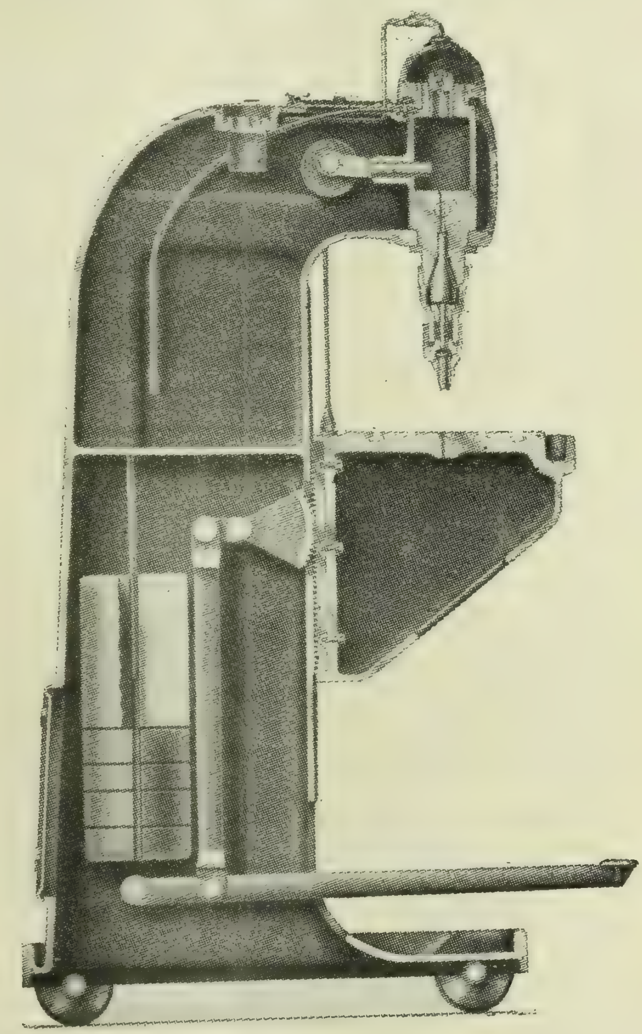
Equipment.

The equipment necessary for the transmission of energy by wave motion is very simple, and consists of:—

(*a*) A wave generator comprising one or more cylinders, each fitted with a piston and connected by a crankshaft to any form of prime mover, such as electric motor, steam engine, etc. With three cylinders spaced at 120 degs., and connected by three separate pipes, the generator would be of the three-phase type (analogous to a three-phase electric generator).

transmission efficiency being water. Messrs. Dorman & Co. have produced special piping for the purpose, known as "Flexstel" pipe, and which consists of sections of any desired length fitted with a new type of spherical metal to metal joint, enabling the pipe as a whole to be bent, coiled, or twisted in every conceivable position. In ordinary installations, such as for rock drills, the mean pressure is approximately 750 lb. per square inch (*i.e.*, maximum 1,500 lb.). The higher the pressure for a given diameter of pipe the greater the power that can be transmitted, analogous to the transmission of electricity.





Portable Riveting Machine.

(*b*) A wave motor composed of one or more cylinders each fitted with a piston, the latter suitably connected to the tool or other mechanism desired to be operated. In the case of rock drills, riveting hammers, and the like, the piston is used as a floating hammer to strike directly on the shank end of drill or rivet snap, as the case may be. Where rotary motion is desired the pistons would operate on a crank as is the case of internal combustion motors.

(*c*) A transmission pipe line which may consist of ordinary rigid piping or of suitable flexible piping. The pipe line contains the liquid connecting the generator to the motor, the liquid giving the highest

The length of pipe line must be a multiple of half-wave lengths.

Branch pipes may be either in the form of Y connections or T connections.

In many respects this new system of transmission resembles alternating current electrical transmission, showing that this purely physical method of transmitting energy is closely allied to the alternating current electrical system. The laws and formulæ of wave and of electrical transmission coincide to the extent that they are almost interchangeable. In wave transmission, there are direct equivalents for volts, amperes, frequency, single and polyphase systems, etc.

Application.

The application of the principle of power transmission by wave motion is restricted at present to the field occupied by compressed air, but it is claimed that the range of its possible applications is theoretically almost unlimited and universal. Its success, obviously, will consist in the degree to which it can be proved to surpass other systems in economy, convenience and safety. A series of tools and appliances have been designed and made by Messrs. Dorman as, for example, riveting hammer and rock drills, and they have the great quality of being simple and without any complicated and delicate parts. Take the riveter, for example. The only wearing parts are the striking end of the hammer, which, being detachable, is easily renewed at small cost; the same remark applies to the rivet snap. The cost of maintenance is very small, as there is only one moving part, and no valves or other refinements. The entire machine is made of the best steel. The body is a plain steel shell in one piece, which encloses the hammer, a plain cylindrical steel forging. This is in two pieces. Two small packing rings of special composition prevent any leakage. These are readily adjustable from the outside by a gland which also acts as the snap retainer. The rivet snap is of the usual form.

The principle of operation is that the waves of energy, when admitted to the hammer element through the control cock which is situated in the inlet piece, act on the end of the hammer, throwing it forward until the front end strikes the rivet snap. Surrounding the hammer is a chamber or space which is called a capacity. This capacity is completely filled with water and fulfils the function of a fluid spring. Due to the difference in diameter between the striking end of the hammer and the piston end, a displacement takes place on the forward stroke of the hammer which compresses the water in the capacity, so that on the pressure in the line dropping below mean pressure, the force acting on the annulus is greater than the force on the end of the hammer, therefore the hammer returns to its backward position ready to receive the next pressure wave. The capacity in conjunction with the hammer is designed to give the hammer a natural period of vibration equal to that of the generator, *i.e.*, 40 complete vibrations per second, or 2,400 blows per minute. It is stated that with this riveter there is a saving of power of 80 per cent.

The portable riveting machine is extremely interesting, as being the first example of the incorporation in a single unit of mechanism for the generation and utilisation of wave power. It comprises a generator, tool, pump, changing valve, and adjustable rising and falling table. The system may be charged with oil, which serves also for lubrication, one pump sufficing for both purposes. In the system there are two capacities, the generator capacity and the tool capacity, and they are designed to contain a certain volume of oil, the pressure variation in each being the same. Oil is delivered by the pump to a hollow detachable dome over the generator. At the highest point of the dome there is a pipe which allows the escape of air.

By means of the generator the power derived from the prime mover is converted into waves of energy. The parts of the generator are a capacity, crankshaft, connecting rod, gudgeon pin and plunger. All the parts are within the overhanging arm of the column, and each is of ample dimensions. The capacity is a hollow steel forging having at its lower end an extension through which a circular passage communicates with the wave tool. An external boss forms a cylinder in which the plunger reciprocates. The crankshaft is supported on two bearings, one on each side of the column arm. The connecting rod is of the usual type secured to the plunger by a gudgeon pin.

At each forward stroke of the plunger, the oil within the capacity is compressed, and expands on the return stroke. Pressure waves are thereby produced, according to the speed of the prime mover. This machine is designed for a frequency of 40 cycles per second, producing 2,400 blows per minute at the hammer end. Riveting is necessarily an intermittent operation, but the production of waves by the generator is continuous. When riveting is not proceeding, however, no power is consumed by the riveting machine other than a negligible amount required to overcome the friction in the bearings. In all wave-power appliances when work is not being done, the capacity fulfils the function of a spring, absorbing energy on the forward stroke of the plunger and restoring it on the return stroke. The hammer, in conjunction with the surrounding capacity, forms a resonator. Hence, the hammer has a natural period of vibration corresponding to the speed of reciprocation of the generator plunger.

The arrangement for operating the machine is simple and convenient. To apply the pressure waves to the hammer, the handle operating the control cock is lowered. After heading a rivet the handle is returned and maintained in the vertical position by a spring.

In Mines.

There is every probability that wave power will become a serious competitor of electricty in coal mines, because its use will not be limited owing to the fear of explosion. Compressed air, however, is well to the front in this field, but if the economic and other advantages claimed for wave-power transmission are well founded, it may supersede compressed air for nearly all mining purposes, especially rock drills.

It is claimed for wave-power transmission that the overall efficiency will be at least 50 per cent under mine conditions, so that by comparison with air we have the following:—Drills at working face, 100 H.P.; power to drive air compressor, 1,000 H.P. (10 per cent efficiency); power to drive wave generator, 200 H.P. (50 per cent efficiency); saving in favour of wave power, 800 H.P.

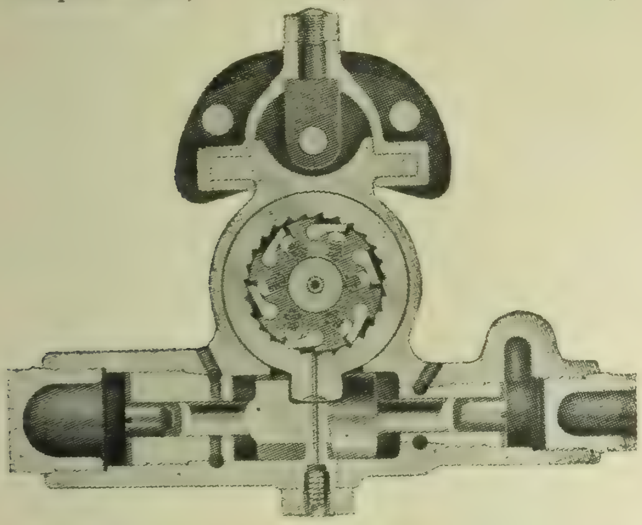
In other words, the installation of wave transmission, it is claimed, would save 80 per cent of the power at present expended in driving air compressors. It is also claimed that the maintenance costs of wave-power tools would be about 33 per cent only, as compared with about 100 per cent in the case of air.

Bringing the claims down to a comparsion of costs, we have the following (extracted from the maker's brochure).

A moderate sized mine will require 500 H.P. at working places under ground, therefore the figures would be:—Prime movers for compressed air, 5,000

H.P. (10 per cent efficiency); prime movers for wave power, 1,000 H.P. (50 per cent efficiency).

At a moderate four hours per day and 312 days per annum, with 0·5d. per brake horse power hour:—Compressed air, 4 x 312 x 5,000 x 0·5d., £13,000 per



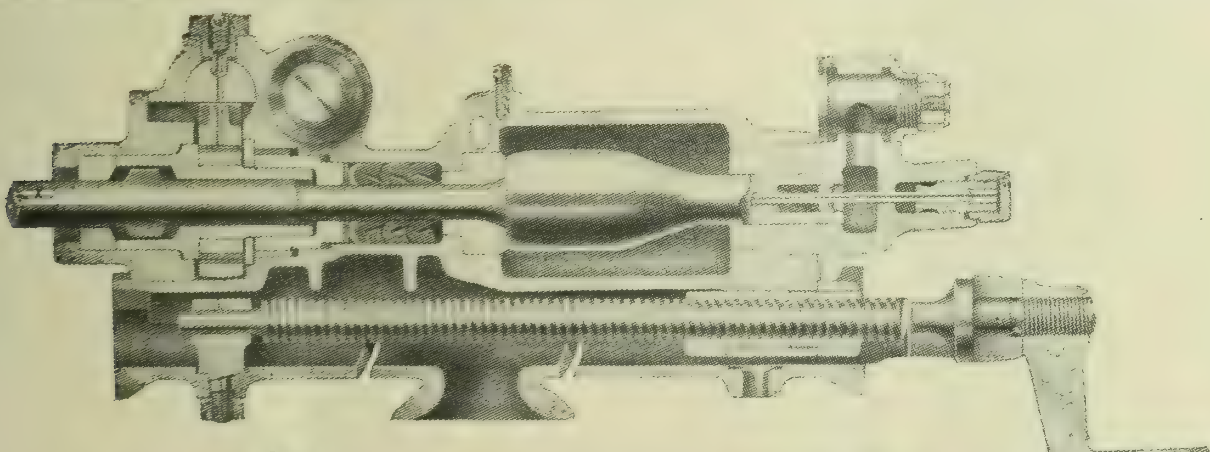
annum; wave power, 4 x 312 x 1,000 x 0·5., £2,600 per annum; saving in cost of power alone, £10,400 per annum.

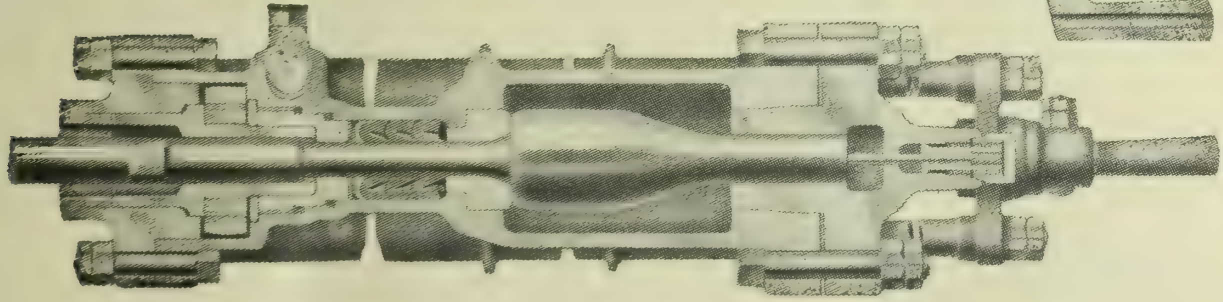
To this must be added the saving claimed for maintenance of drills, etc., and taking 100 drills at £100 each, with 100 per cent per annum for air, and 33 per cent per annum for wave power, the saving in favour of wave power would be no less than £6,700 per annum. The total saving by these two items would, therefore, be, in round figures, £17,000 per annum.

There are different types of rock drills. The M1 type has been designed to conform to the standard size and weight of the pneumatic hammer drill used in mining. The drill base is made so that it will fit into the standard pneumatic cradle feeds, and the chuck will accommodate the ordinary size and shape of drill shank. Rotation of the drill chuck is effected by an independent motor, which cannot get out of synchronism with the hammer, as they are both operated by the same wave power impulses. The motor is of simple design, consisting only of a plunger working into a fluid capacity or chamber. The plunger actuates the ratchet ring in engagement with pawls in the chuck, as shown in the accompanying illustration.

A water flush is incorporated for washing the debris out of the hole, which ensures the drilling being dustless, and at the same time, the water cools the drill steel and substantially increases the rate of penetration. The water feed is controlled from the back end of the machine, whilst the drill is working, and can be regulated instantly to suit the different classes of ground being cut. A steel water tube passes through the hammer from the back end of the inlet piece and enters the hollow drill steel. A simple needle valve operated from the outside controls the amount of water passing through. The volume can be regulated to suit varying requirements without stopping the drill.

The possible applications of wave power are very numerous. It will not supersede the electric motor for many purposes, and a forecast of its usefulness





would be without any value, but, as Mr. Walter Haddon truly says of the invention, "The road of future development is open for all and sundry to add their quota of scientific and technical knowledge, and by none will they be more heartily welcomed than by those of us who have acted as pioneers."

PNEUMATIC ELEVATORS.

By Professor William Cramp, D.Sc.*

Pneumatic elevators were invented in England; the first practicable machines being those of F. E. Duckham about 18.7, which were used for grain. Up to 1914, however, little development had taken place in this country, but in Germany their design had been studied and their uses largely extended, so that most of the chief ports of that country were equipped with one or more floating elevators, and there were also many inland examples. At the outbreak of war, on account of the necessity of transporting large quantities of grain quickly and economically for the armies in the field, their use received a great impetus in this country, and the Government ordered several large plants costing more than £20,000 each. The Office of Works also ordered a number of small plants for special purposes in 1918.

The attention of the author was first drawn to this subject in 1913, when, having made himself familiar with Continental practice, he began a research which was interrupted by the war in 1915. Subsequently he approached, in 1918, the newly-formed Department of Scientific and Industrial Research, which gave him a grant towards the expenses of a research to be carried out in connection with a plant provided by Messrs. Thomas Robinson & Sons, of Rochdale. The research was proceeded with at Manchester University with the permission of Sir J. E. Petavel, and the work was largely carried out by Mr. A. Priestley, M.Sc.

The experiments were confined to wheat, this being a material frequently elevated by pneumatic means, and having fairly constant dimensions. The power required to elevate granular material at a given rate can be expressed in terms of the difference of pressure across the conveying pipe, and the quantity of air per second moved under this pressure difference. The part of this which appears as useful power can be expressed in terms of the weight of material lifted per second and the height to which it is raised. The ratio of these two powers gives the efficiency of the plant. It is evidently easy to determine this experimentally, but there are great difficulties in formulating a satisfactory theory connecting the large number of variables in the appropriate equations. With a given current of air, it is necessary to determine and connect reliable expressions for the following quantities:—

(1) The force, acceleration and velocity with which the material is moved in air of varying density.

(2) The retarding forces on the material.

(3) The retarding forces on the air.

In order to arrive at the force acting on the material, a number of experiments were made with special apparatus, and from these a factor was arrived at which, when multiplied by the square of the velocity of the air relative to the grain, gave the force on each berry within certain limits. Using this factor, a series of velocity distance curves could be deduced from the appropriate velocity equation, assuming the density of the air to be constant. This velocity was then checked by measurements made on the complete plant, but the results were not found to be altogether consistent, the calculated value of the mean velocity being usually higher than the experimental value, due no doubt to friction between the grain and the pipe.

*From a paper read before the British Association at Cardiff.

No satisfactory experimental means of separating this friction from other phenomena were available, and ultimately it was necessary, in the absence of a complete theory of the motion of the particles, to deduce the value of this force from repeated comparisons between theory and experiment, until a satisfactory expression, having a rational basis, was arrived at. The other forces acting in the system, viz., the friction between the air and the pipe, and that between the grain and the air, were similarly dealt with until all the factors required for connecting the forces with the changes of momentum had been accounted for and a general equation could be written down.

The constants depend chiefly upon the type of material which is being elevated, and were all determined for the wheat used, and the results were then checked against the actual figures obtained from experiments upon the complete plant. The results of this comparison are given in the appended table of calculated and actual vacua for a pipe 9 m. long and 4·8 cm. diameter.

In the course of the experiments the influence of the form of nozzle used became prominent. Tests were made, therefore, on a number of nozzles to ascertain the manner in which they influenced the behaviour of the elevator. It was found that for each type of nozzle there was a certain constant representing the number of tons drawn into the nozzle per hour per square centimetre of of nozzle area per metre per second of air velocity at the nozzle, calculated on the full nozzle area. This has an important bearing on the amount that a given plant can lift per hour. Since mechanical elevators can be designed to work with an efficiency of 75 per cent, it is very important that the maximum theoretical efficiency of a pneumatic elevator should be known and compared with its rival. If we regard the velocity energy of the grain as a loss, which is usually the case, then for various shapes of pipe, giving different accelerations, the theoretical efficiency cannot exceed 40 per cent. In practice no pneumatic elevator approaches this efficiency, and yet they are used because of their labour-saving qualities and freedom from dust. From the equations and experimental work it would seem that there is no reason why the efficiency of commercial plant should not easily be doubled, and if the results of this research are put into operation it seems certain that an improvement of this order will be effected.

Tons per hour lifted.	Va. Metres per second.	Vacuum calculated cms. of mercury.	Vacuum measured cms. of mercury.
1·39	20	7·3	7·2
	30	10·5	10·8
	41	14·8	13·5
2·38	19	10·4	11·2
	33	16·1	16·8
3·72	19	14·6	15·3
	29	19·6	19·6
	37	24·6	23·8
4·85	18	17·7	18
	26	21·9	22·3
	34	27·4	26·4
6·3	27	27·4	27·5

DROP FORGING.

By P. Rowley, B.Sc.

In the production of a sound drop forging there are three essentials to success, namely, sound material, correct design, and careful working.

Defects in the Steel.

To produce a forging in perfect finished condition it is obvious that the material must also be perfect, and the contention on the part of many steel manufacturers that seams, roaks, and laps (Figs. 1, 2, and 3) will weld up in the forging process is not borne out in practice, the inevitable result being defective forgings.

It is impossible to weld up any crack the walls of which are oxidised, and in almost all cases, parti-

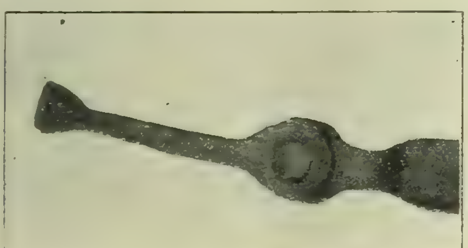


Fig. 1.—Seam Opened Out in partly forged Connecting Rod.

cularly where the material is spread by a peg in the die, the cracks extend, and, although many of the defects may clean up during machining, the heat treatment to which the forgings are subjected before delivery extends the cracks.

Many surface defects can be got rid of by careful working, but this in itself is no excuse for their presence.

The contention that cracks in the ends of cropped billets are no indication of unsoundness cannot be admitted, for experience shows that in these cases

Fig. 2.—Seams Opened Out up-ending process.

surface defects are present, which result in seamy forgings, and it is therefore useless for such material to be accepted.

Since the war, automobile manufacturers have tightened up considerably their system of inspection, which has caused drop forgers to institute proper inspection departments, and it would be very beneficial if steel makers also were to adopt stricter inspection measures, since the loss caused by the supply of defective material cannot be covered merely by the supply of sound steel to replace it. The time lost and labour charges, together with wear and tear of

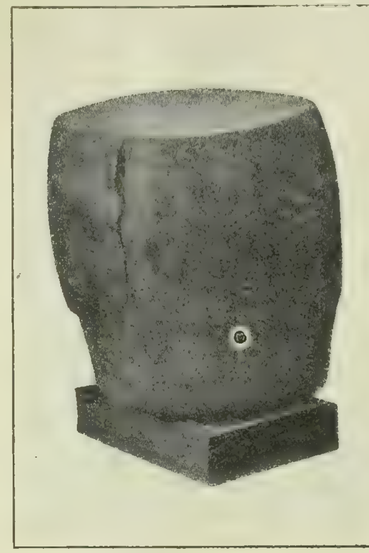


Fig. 3.—Lap formed in Rolling of a Billet.

dies and delay in delivery, must also be taken into account.

Defects which can be avoided by careful inspection

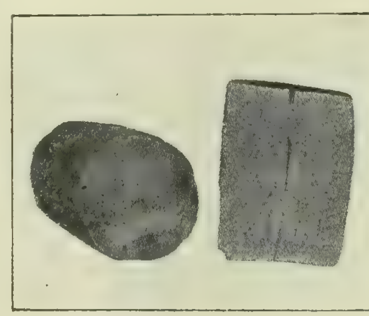


Fig. 4.—Piping in Billets.

of billets after rolling are, however, not the only ones. These are present below the surface, and are seldom located unless the steel has been cold sawn,

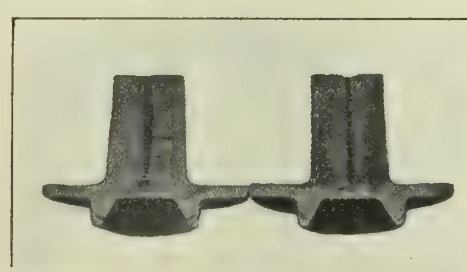


Fig. 5.—Piped Forging split during Quenching.

and even then they may not become apparent until after heat treatment or machining operations have been started.

* Being a paper presented to the Association of Drop Forgers and Stampers.

This refers principally to piping in billets (Fig. 4), which is chiefly due to false economy on the part of the steel manufacturer in not discarding sufficient from the top of the ingot. In some cases, of course, the pipe may be bored out in the subsequent machining, but frequently the hardness of the slag in the pipe destroys the drill point. Apart from this, cases occur in which the forces set up during contraction of the piece on quenching are sufficient to split the forging (Fig. 5).

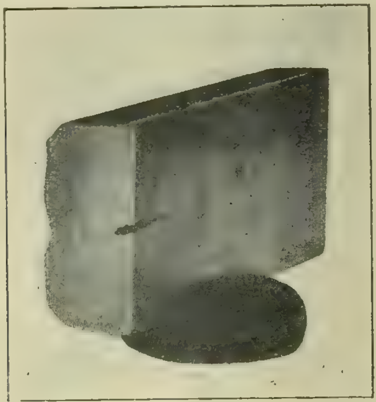


FIG. 6.—Contraction Cavity in Billet.

Contraction cavities are occasionally met with, which are only revealed when the material is sawn up into lengths (Fig. 6).

Another serious trouble, principally found in carbon case-hardening steels, manifests itself as apparent seams when machining operations are commenced. This defect is due to blow holes below the surface of the original ingot, which, in some cases, have become filled with segregates, such as manganese sulphide, or, possibly, silicates. When the ingot is rolled down these inclusions take the form of internal streaks or "ghosts," and they are particularly troublesome, as their depth below the surface varies. Sometimes the finished size is

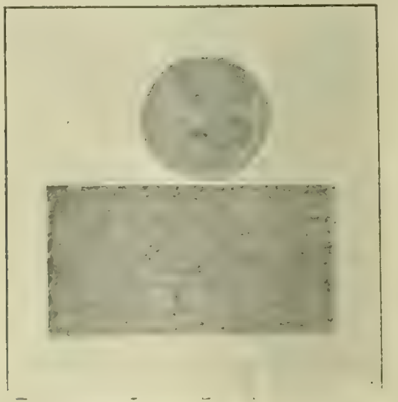


FIG. 7.—Surface Section from Bevel Pinion.

reached before getting down to these lines, while at other times they are near the skin and are removed, but there are many rejections for this defect, the streaks showing in the final surface of the machined article.

Being formed during the cooling of the ingot, the ghosts are parallel to the surface, and the finally machined surface is therefore full of fine cracks (Figs. 7 and 8). During carbonisation and subsequent hardening, wide cracks are developed, and the machinist should therefore be very careful to reject any parts showing these defects, as such might lead to very serious results.

The demand for very low sulphur steels is no doubt very much overdone, and steel makers often receive complaints concerning steels which are in reality quite good. If the sulphide be well distributed, practically no harmful effects will be noticed, but it is only possible to differentiate between well-distributed sulphide and large segregates by microscopic examination. There is no doubt that the

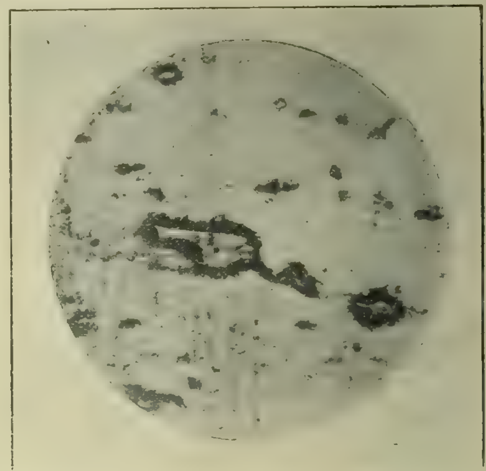


FIG. 8.—Sulphide Inclusions in Carbon Case-hardening Steel.

microscope should be put to greater use in conjunction with the chemical analysis of steels.

Considerable trouble is often experienced owing to segregation of various constituents in the steel billets, and manganese sulphide is probably that which most frequently occurs, but segregations of other constitutents, although not so common, are sometimes present in billets, and very serious trouble may result from them. As an example, complaints were received from the machinists that many of the connecting rods made from a particular batch of

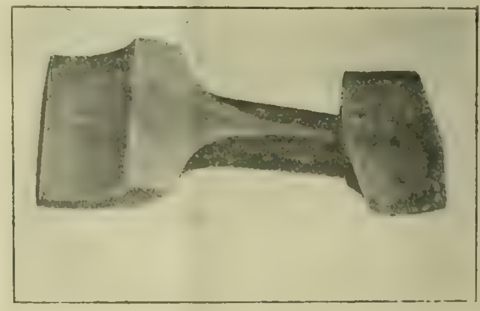


FIG. 9.—High Carbon Patches in Nickel Chrome Steel.

billets were too hard to machine. Every forging had been brindled in three places (on the two bosses and on the side), and none were passed through unless between the limits 255 to 302. In this range a nickel chrome steel should be machined without difficulty. On examination of the parts in question it was found that boring operations were carried out to some depth before the hard patches were encountered. Now, is it possible by uneven tempering to produce a connecting rod machinable at one end and too hard at the other, especially when tempering at the

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 100 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	8 3 20	0 17 3 12	1 6 3 4	1 15 2 24	2 4 2 16	2 13 2 8	3 2 2 0	3 11 1 20	4 0 1 12	0
1	0 3 16	9 3 8	0 18 3 0	1 7 2 20	1 16 2 12	2 5 2 4	2 14 1 24	3 3 1 16	3 12 1 8	4 1 1 0	1
2	1 3 4	10 2 24	0 19 2 16	1 8 2 8	1 17 2 0	2 6 1 20	2 15 1 12	3 4 1 4	3 13 0 24	4 2 0 16	2
3	2 2 20	11 2 12	1 0 2 4	1 9 1 24	1 18 1 16	2 7 1 8	2 16 1 0	3 5 0 20	3 14 0 12	4 3 0 4	3
4	3 2 8	12 2 0	1 1 1 20	1 10 1 12	1 19 1 4	2 8 0 24	2 17 0 16	3 6 0 8	3 15 0 0	4 3 3 20	4
5	4 1 24	13 1 16	1 2 1 8	1 11 1 0	2 0 0 20	2 9 0 12	2 18 0 4	3 6 3 24	3 15 3 16	4 4 3 8	5
6	5 1 12	14 1 4	1 3 0 24	1 12 0 16	2 1 0 8	2 10 0 0	2 18 3 20	3 7 3 12	3 16 3 4	4 5 2 24	6
7	6 1 0	15 0 20	1 4 0 12	1 13 0 4	2 1 3 24	2 10 3 16	2 19 3 8	3 8 3 0	3 17 2 20	4 6 2 12	7
8	7 0 16	16 0 8	1 5 0 0	1 13 3 20	2 2 2 12	2 11 3 4	3 0 2 24	3 9 2 16	3 18 2 8	4 7 2 0	8
9	8 0 4	16 3 24	1 5 3 16	1 14 3 8	2 3 2 0	2 12 2 20	3 1 2 12	3 10 2 4	3 19 1 24	4 8 1 16	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs	q lbs.	Weight.
	8·34	16·68	25·02	1 5·36	1 13·7	1 22·04	2 2·38	2 10·72	2 19·06	2 27·40	3 7·74	3 16	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 100 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 9 1 4	8 18 2 8	13 7 3 12	17 17 0 16	22 6 1 20	26 15 2 24	31 5 0 0	35 14 1 4	40 3 2 8	0
10	0 8 3 20	4 18 0 24	9 7 2 0	13 16 3 4	18 6 0 8	22 15 1 12	27 4 2 16	31 13 3 20	36 3 0 24	40 12 2 0	10
20	0 17 3 12	5 7 0 16	9 16 1 20	14 5 2 24	18 15 0 0	23 4 1 4	27 13 2 8	32 2 3 12	36 12 0 16	41 1 1 20	20
30	1 6 3 4	5 16 0 8	10 5 1 12	14 14 2 16	19 3 3 20	23 13 0 24	28 2 2 0	32 11 3 4	37 1 0 8	41 10 1 12	30
40	1 15 2 24	6 5 0 0	10 14 1 4	15 3 2 8	19 12 3 12	24 2 0 16	28 11 1 20	33 0 2 24	37 10 0 0	41 19 1 4	40
50	2 4 2 16	6 13 3 20	11 3 0 24	15 12 2 0	20 1 3 4	24 11 0 8	29 0 1 12	33 9 2 16	37 18 3 20	42 8 0 24	50
60	2 13 2 8	7 2 3 12	11 12 0 16	16 1 1 20	20 10 2 24	25 0 0 0	29 9 1 4	33 18 2 8	38 7 3 12	42 17 0 16	60
70	3 2 2 0	7 11 3 4	12 1 0 8	16 10 1 12	20 19 2 16	25 8 3 20	29 18 0 24	34 7 2 0	38 16 3 4	43 6 0 8	70
80	3 11 1 20	8 0 2 24	12 10 0 0	16 19 1 4	21 8 2 8	25 17 3 12	30 7 0 16	34 16 1 20	39 5 2 20	43 15 0 0	80
90	4 0 1 12	8 9 2 16	12 18 3 20	17 8 0 24	21 17 2 0	26 6 3 4	30 16 0 8	35 5 1 12	39 14 2 16	44 3 3 20	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lb	Weight.
	44 12 3 12	89 5 2 24	133 18 2 8	178 11 1 20	223 4 1 4	267 17 0 16	312 10 0 0	357 2 3 12	401 15 2 20	446 8 2 8	

Compiled and Arranged by T. E. Woodhouse

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 101 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 0 2	0 18 0 4	1 7 0 6	1 16 0 8	2 5 0 10	2 14 0 12	3 3 0 14	3 12 0 16	4 1 0 18	0
1	0 3 17	9 3 19	0 18 3 21	1 7 3 23	1 16 3 25	2 5 3 27	2 15 0 1	3 4 0 3	3 13 0 5	4 2 0 7	1
2	1 3 6	10 3 8	0 19 3 10	1 8 3 12	1 17 3 14	2 6 3 16	2 15 3 18	3 4 3 20	3 13 3 22	4 2 3 24	2
3	2 2 23	11 2 25	1 0 2 27	1 9 3 1	1 18 3 3	2 7 3 5	2 16 3 7	3 5 3 9	3 14 3 11	4 3 3 13	3
4	3 2 12	12 2 14	1 1 2 16	1 10 2 18	1 19 2 20	2 8 2 22	2 17 2 24	3 6 2 26	3 15 3 0	4 4 3 2	4
5	4 2 1	13 2 3	1 2 2 5	1 11 2 7	2 0 2 9	2 9 2 11	2 18 2 13	3 7 2 15	3 16 2 17	4 5 2 19	5
6	5 1 18	14 1 20	1 3 1 22	1 12 1 24	2 1 1 26	2 10 2 0	2 19 2 2	3 8 2 4	3 17 2 6	4 6 2 8	6
7	6 1 7	15 1 9	1 4 1 11	1 13 1 13	2 2 1 15	2 11 1 17	3 0 1 19	3 9 1 21	3 18 1 23	4 7 1 25	7
8	7 0 24	16 0 26	1 5 1 0	1 14 1 2	2 3 1 4	2 12 1 6	3 1 1 8	3 10 1 10	3 19 1 12	4 8 1 14	8
9	8 0 13	17 0 15	1 6 0 17	1 15 0 19	2 4 0 21	2 13 0 23	3 2 0 25	3 11 0 27	4 0 1 1	4 9 1 3	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·42	16·84	25·26	1 5·68	1 14·10	1 22·52	2 2·94	2 11·36	2 19·78	3 0·20	3 2·62	3 17	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 101 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	Ft.
0	..	4 10 0 20	9 0 1 12	13 10 2 4	18 0 2 24	22 10 3 15	27 1 0 8	31 11 1 0	36 1 1 20	40 11 2 12	0
10	0 9 0 2	4 19 0 22	9 9 1 14	13 19 2 6	18 9 2 26	22 19 3 18	27 10 0 10	32 0 1 2	36 10 1 22	41 0 2 14	10
20	0 18 0 4	5 8 0 24	9 18 1 16	14 8 2 8	18 18 3 0	23 8 3 20	27 19 0 12	32 9 1 4	36 19 1 24	41 9 2 16	20
30	1 7 0 6	5 17 0 26	10 7 1 18	14 17 2 10	19 7 3 2	23 17 3 22	28 8 0 14	32 18 1 6	37 8 1 26	41 18 2 18	30
40	1 16 0 8	6 6 1 0	10 16 1 20	15 6 2 12	19 16 3 4	24 6 3 24	28 17 0 16	33 7 1 8	37 17 2 0	42 7 2 20	40
50	2 5 0 10	6 15 1 2	11 5 1 22	15 15 2 14	20 5 3 6	24 15 3 26	29 6 0 18	33 16 1 10	38 6 2 2	42 16 2 22	50
60	2 14 0 12	7 4 1 4	11 14 1 24	16 4 2 16	20 14 3 8	25 5 0 0	29 15 0 20	34 5 1 12	38 15 2 4	43 5 2 24	60
70	3 3 0 14	7 13 1 6	12 3 1 26	16 13 2 18	21 3 3 10	25 14 0 2	30 4 0 22	34 14 1 14	39 4 2 6	43 14 2 26	70
80	3 12 0 16	8 2 1 8	12 12 2 0	17 2 2 20	21 12 3 12	26 3 0 4	30 13 0 24	35 3 1 16	39 13 2 8	44 3 3 0	80
90	4 1 0 18	8 11 1 10	13 1 2 2	17 11 2 22	22 1 3 14	26 12 0 6	31 2 0 26	35 12 1 18	40 2 2 10	44 12 3 2	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	Weight.
	45 1 3 4	90 3 2 8	135 5 1 12	180 7 0 16	225 8 3 20	270 10 2 24	315 12 2 0	360 14 1 4	405 16 0 8	450 17 3 12	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

highest limits; but it is difficult to produce a forging soft on the outside and hard at the centre, unless, of course, the piece has been withdrawn from the furnace without thoroughly soaking. It seemed, therefore, fairly certain that the trouble arose from some inequality in the composition of the steel. On cutting through the centre of a rod, polishing, and etching, it proved that this was the case, a central core being evidenced which etched darker than the outer parts Fig. 9).

On estimating the carbon contents of the two layers, it was found that the outer part had a carbon content of 0·37 per cent, while the inner portion contained approximately 1·0 per cent carbon. This segregation of carbon was due to the method used by the steel maker to prevent piping of the ingot. The ingots were cast in moulds fitted with feeder heads, and on the surface of the molten metal was placed a layer of charcoal, which was kept aglow by an air blast. This kept the metal at the top of the mould in a molten condition, and allowed it to sink down as contraction took place. The fused slag should prevent direct contact between the carbon and the steel, but it sometimes happens that the steel which solidifies round the sides of the feeder head becomes carbonised, and is then melted by the burning charcoal. This penetrates the slag, and unless the head be well filled, the main part of the ingot becomes impregnated with a pipe of high carbon steel.

Another interesting trouble appeared in a certain consignment of 5 per cent nickel case-hardening steel for gear blanks. On forging from this steel it was found that a large number developed serious cracks. These were rough turned to see if it would be possible to remove the cracks without scrapping the forgings, but in every case bright patches of metal became evident, the cracks extending along the borders of these patches (Fig. 10). On analysing chippings from these bright areas, it was found that they were very high in nickel content, some chippings showing as much as 20 per cent nickel (Fig. 11). These parts could not possibly be used, as the cracks were bound to extend in carbonising operations, apart from the fact that the nickel patches would remain soft. It was fairly obvious that the nickel in this steel had been added to the ladle without sufficient mixing before pouring.

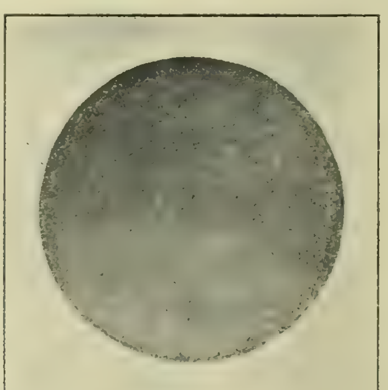


FIG. 10.- Inclusions of Free Nickel in 5% Nickel Case-hardening Steel.

Steels of high phosphorus content are apt to give considerable trouble, especially where cold clipping has to be carried out. A case illustrating this point occurred in which shell bases were being made in sprays of two, the scrap being removed from the forgings by cold clipping. With certain consignments of steel great trouble was experienced owing the the clipping beds breaking, and many of the forgings split along the scrap line. Several discs were analysed, with the following results:—

	Carbon.	Sulphur.	Phosphorus.	Manganese.
Disc which clipped well	·552	·022	·056	·758
Ditto	·559	·020	·058	·747
Disc which split on clipping	·66	·025	·117	·76
Ditto	·599	·025	·112	·859

It will be noticed that the forgings which split were high in phosphorus content, the effect of which is to harden the steel, and with high carbon the effect was increased, the steel becoming "cold short" to a marked degree. It should be noted that in the case of a high phosphorus steel the Brinell numeral does not bear the usual ratio to the tensile strength, the actual strength being considerably higher.

FIG. 11.—Inclusions of Free Nickel magnified one hundred times.

A matter which at times gives rise to very serious trouble is the mixing up of billets at the steel manufacturers' works, and cases are on record in which the resultant forgings varied considerably as regards the Brinell number, while analysis showed that a portion of the batch were of nickel chrome, the remainder being 3 per cent nickel case-hardening steel. Every billet of the particular batch bore the makers' stamped mark, showing that the ingots had been mixed at the manufacturers' works. It is obvious that very grave results may arise from lack of care in the steel stores.

An argument frequently brought forward by steel manufacturers regarding defective billets is that the method of heating the billets is too drastic, and that they should be charged into a cold furnace and slowly brought up to the requisite temperature. Many cases of cracking and of surface defects are attributed to quick heating. However, few cases are met with in which sound carbon steel billets crack in the furnace, but if a billet be unsound the defects are no doubt developed further by quick heating, and it is better that this should take place rather than that unsound steel should be worked up into the forged state.

(To be continued.)

POWER TRANSMISSION BY OIL PRESSURE.

By John D. Troup, M.I.Mech.E.

During recent years a great deal of attention has been devoted to evolving a flexible transmission gear; that is to say, a gear which is capable of giving speed variations from zero up to the maximum speed of the gear, over an infinite number of stages. Many attempts have been made to do this by purely mechanical means, but the only mechanism which may be said to be flexible is the friction gear.

To meet this demend for flexibility, the hydraulic method of power transmission has been developed on new lines. So far the modern apparatus has only been used in sizes up to 200 H.P., and has been applied principally for ships' steering gear, cranes, and operating heavy naval guns. Sufficient experience has, however, been gained to show that the hydraulic method has a very large field of application throughout the whole industrial world. It has been successfully applied for heavy motor lorry work, where it replaces the ordinary gear box and dispenses with the clutch and differential. The lorry is controlled by one lever, much in the same way as a steam lorry would be controlled, and with the same infinite range of speeds. To reverse the lorry is the simple operation of moving the control lever in the opposite direction, and the whole gear is foolproof and entirely free from the shocks of the mechanical system.

The Oil Pump.

There are at present three principle systems in regular use, namely, the Hele-Shaw, Williams-Janney, and Carey. Each of these systems follows the same general principles, but they differ in their methods of carrying out these principles.

The essential unit of all these systems is the oil pump. This is a specially designed high-speed multi-cylinder pump, which may be driven by any convenient means, such as electric motor, internal-combustion engine, or by belt from a line shaft. The function of this pump is to create pressure in the oil system, when the oil under pressure is conveyed to the special motor, which in its turn converts the oil pressure into rotating motion, and so drives the machine requiring power. The rotary motor is a multi-cylinder unit similar to the oil pump, but in some cases it is not used. Such cases are those where a ram is more convenient, such as converted hydraulic cranes and lifts and ships' steering gear.

The oil pump and motor (or ram) are coupled up together with a delivery and return oil pipe, so as to form a closed circuit for the oil system, and any leakage of oil which may take place is made up automatically.

The fundamental feature of the oil pump is its capability of giving a varying output, which is effected by varying the stroke of the pump pistons. This is done by the simple movement of one lever, as will be seen presently, and the effect of a reduced or increased output from the pump makes a corresponding reduction or increase in the speed of the motor or ram at the other end of the closed oil circuit. It will thus be seen that such a system enables any degree of speed variation to be obtained, and without shock or noise. To reverse the motor it is only necessary to move the operating lever in the opposite direction.

The Hele-Shaw Pump.

Describing first the Hele-Shaw pump, this consists of seven small radial cylinders revolving on one central shaft. These cylinders project from a revolving drum, which has seven radial holes, each of which communicates with the bottom end of each cylinder. The shaft on which this drum rotates has two grooves or ports on opposite sides of the shaft, or 180 deg. apart. One of these grooves acts as an oil delivery port, and the other for the suction, the pistons in each case being timed to be on their delivery or suction stroke. It will thus be seen that the valve functioning is positive, there being no loose valves to get out of order.

Returning to the cylinders, these are open at the top or outer end, and each contains a plunger-type piston. Each piston has a gudgeon pin, which in turn carries a slipper, which is curved to fit into a circular groove in the sides of a hollow drum which completely encases the rotating cylinders. This drum is for the purpose of varying the piston stroke of the pump. If it is assumed that this drum, or "floating ring," as it is called, is concentric with the cylinder boss, then no reciprocating motion of the pump pistons would be possible. But as soon as the floating ring is moved horizontally, then it becomes eccentric with the rotating cylinders, and thus gives the pistons reciprocating motion, the amount of motion, or stroke of the pistons, being dependent upon the amount of eccentricity.

The floating ring is mounted on ball bearings placed in a special guide-block on either side of the pump boss. This ring is capable of horizontal movement by means of external gear, which is the stroke control mechanism. Motion is given to the pump through a projection of the pump boss, so that the floating ring is rotated by the motion being conveyed from the cylinder through the pistons and their gudgeon pins; the friction of the gudgeon pin slippers in the groove of the floating ring being greater than that of the ball bearings, the floating ring is forced to rotate with the pump cylinders.

The Williams-Janney Pump.

The Williams-Janney pump is also of the multi-cylinder type, but in this design the cylinders are placed parallel with the rotating pump shaft, and are arranged at equal distances in a circle surrounding the shaft. A revolving drum forms the cylinders, each cylinder bore being in the side of this drum and at equal distances round a circle. The other side of this cylinder drum revolves against a fixed face in which ports are cut for the supply and delivery of the oil, the functioning of these ports being somewhat similar to the operation of a steam engine slide valve.

Each pump piston is fitted with connecting rod, each end of which is formed into a ball, one end fitting into a socket in the piston and the other end fitting into a socket in another rotating disc. This rotating disc is the essential part for giving the variable stroke to the pistons, and is the equivalent of the floating ring in the Hele-Shaw pump. The rotating disc to which all the piston rods are attached rotates against a roller-bearing race, which is carried in a stationary disc placed over the pump shaft. This stationary disc is capable of being placed

at any angle with the pump shaft by means of external gear. The revolving disc carrying the piston ends, which is pressed against the stationary disc by spring pressure and is also mounted on a universal joint, is thus forced to take the same inclination as the stationary disc. Assuming that the stationary disc is at right angles to the pump shaft, then no reciprocating motion of the pump pistons can take place, but as soon as the stationary disc make any angle with the pump shaft, then reciprocating motion is given to the pistons. The amount of inclination determines the stroke of the pump, just as the amount of eccentricity in the Hele-Shaw floating ring determines the stroke of the pump.

The Carey Pump.

Lastly, there is the Carey pump, and this is of distinctly novel design. It consists of a rotating drum, one side of which carries the supply and delivery ports for the oil, and it works against a fixed face which forms one side of the pump casing. The rotating drum is bored radially to form the pump cylinders, and in this respect it resembles the Hele-Shaw pump, but in place of plunger pistons being fitted mettalic balls are used as pistons. When the rotating drum is working, these balls are thrown outwards by centrifugal force and are held in place by a surrounding ring which forms a track for the balls. This ring, together with the cylinder drum, is mounted within a pump casing, but the ring is free to move up or down by means of external gear. It is this vertical movement which varies the stroke of the pump. When the guide ring is concentric with the pump shaft the piston balls simply run round it, keeping the same distance from the centre of the shaft. But as soon as the guide ring is moved up or down the balls are forced to take an eccentric course, and thus are given reciprocating motion. The functioning is therefore similar to the two former pumps, but the mechanical efficiency must be higher, due to this simple and novel construction.—*Manchester Guardian.*

A Record "Pacific" Submarine.—M. Laubaus, the inventor of various types of submarine apparatus, gave a description at the Academie des Sciences, Paris, recently of a new submarine which he has just invented. It is claimed that this submarine, which is creator described as "pacific," is capable of diving to a depth of more than 300 ft. for the purpose of conducting oceanographic and submarine researches. This depth, said M. Laubaus, had never been reached.—Reuter.

Technical Lectures.—The following programme of lectures has been arranged by the York branch of the Association of Engineering and Shipbuilding Draughtsmen: Thursday, 11th November, "Gear Tooth Forms," E. W. Tipple, Esq., Leeds; Saturday, 20th November, "Steel Tubes and Cylinders," F. S. Marsh, Esq., M.Sc. (Leeds), B.Sc. (Lond.), Chesterfield; Thursday, 9th December, "Astronomical Instruments," J. Scott, Esq., York; Thursday, 6th January, "Distilling and Stills," W. A. Warner, Esq., Huddersfield; Thursday, 27th January, "The Design of Stanchions," P. G. Kemp, Esq., Chesterfield; Thursday, 17th February, "Modern Boiler House Operation," M. Cohen, Esq., B.Eng. (Liverpool), York; Thursday, 10th March, "Wireless Telegraphy," E. Backhouse, Esq., York; Thursday, 31st March, "Iron and Steel," J. W. Dow, Esq., M.I.M.E., York; Thursday, 14th April, "Cranes and Ropeways," A. M. Maclaren, Esq., York. All the lectures are timed to commence at 7.15 p.m. on each of the foregoing dates. The price of the syllabus (including admission to all lectures) is: Members, 2s. 6d.; non-members, 5s. Further particulars may be had from the hon. technical secretary of the A.E.S.D., Mr. A. E. Ellis, 8, Fountayne Street, Haxly Road, York.

THE ASBESTOS INDUSTRY OF GERMANY.

Prior to the war, German requirements of asbestos were chiefly imported, the largest quantity coming from Canada, which has a yearly output of 100,000 tons, and from Russia (Siberia), whose yearly output is 15,000 to 20,000 tons. Supplies were also obtained from the United States, especially from Georgia, Massachusetts, Connecticut, and Virginia, and from Canada, China, and South Africa (in the region of the Orange River). From the last-named territory the asbestos obtained had a particularly white, silky sheen, or was of a bluish-grey colour, produced by the somewhat high content of oxide of iron (approximately 38 per cent). According to the German Press, asbestos mines opened through German agency are as follows: Veltlin (Italy), von Sterzing, Zillerthal, and the St. Gothard in the Tyrol, von Mantern in Steiermark, and in the Government of Perm, near Newjansk (Russia). In addition, asbestos has also been found in Bulgaria and other Balkan States, and at Küstendil, which, however, through excessive decomposition, is of little value. New fields in Bosnia and Turkey are not of great value, owing to their recent establishment, and the discoveries of 1917 in Switzerland are not of great importance. As regards Germany, the oldest and best-known mines are those of Fundort Zöblitz i. Erzgeb. During the war recourse was had to deposits at Thüringen, and in the Reusser Oberland, as well as at Kacholdberg von Lettinghammer, Heberndorf. These fields were known to the German mineral authorities before the war, but were not developed, owing to the favourable supplies of the imported article. War-time developments, as necessitated by the blockade, led to the development of home supplies, with the result that these mines have been satisfactorily worked. Asbestos has also been found at Reichenbach i. Vgtl. and at Bad Steben (Krötenmühle). Although the huge demands of Germany for asbestos has not been met by home production, the latter has resulted in imports being diminished. Before the war the importation of asbestos was about 15,000 tons per year, while the German production of asbestos was only about one-eighth of this amount. In addition to the above, a substitute material has been produced during the war, called "Deutsches Asbest." Various other substitutes have also been produced, the best results being obtained with good quality wool waste, but silk, cotton, and animal hair were also used. About 10 per cent of chloride of magnesium was added, in order to reduce the inflammability. German asbestos is not to be compared with Canadian asbestos. The latter consists of long fibre, and is therefore easily spun. The Thüringen fibre is short and cannot be spun, and the asbestos is therefore chiefly used for boards and for the making of heat insulators, engine packing, etc. German asbestos chiefly appears in asbestos earth as a mixture with ochre and sand. The winning of the asbestos is, on this account, very difficult. There was a large production of asbestos boards during the war, which increased at one time to the extent of a million square metres per month. An Austrian invention of cement bricks has also been taken up.—From *The Board of Trade Journal.*

Big Contract for Cammell Lairds.—The New Zealand Government has accepted the tender of Messrs. Cammell, Laird & Co., for 2,500 railway wagons, the price being £325 each. There were four tenders each received from Great Britain and the United States, and one each from Canada and Germany, for the supply of these wagons.

Association of Engineering and Shipbuilding Draughtsmen (York Technical Section).—The second of the series of lectures arranged by the York sub-branch of the A.E.S.D. was given by Mr. E. Smith, the subject being "Heavy-Oil Engines." Mr. M. Cohen, in opening the proceedings, referred to the importance of the subject in view of the present coal difficulty, also suggesting the menace of oil trusts. Mr. Smith dealt very fully with the theoretical considerations underlying the operation of the three types of heavy oil-engines, namely, hot bulb, Diesel, and semi-Diesel, pointing out that whereas the gas engine operates on the well-known Otto cycle, the Diesel engine is a constant pressure cycle engine. A large number of lantern slides helped the author in his description of the design and mechanical details of the several classes of engines now in operation. Great interest was shown in the progress which has been made during the last few years, both in the growing adoption of the Diesel engine for marine work and the degree of international standardisation attained. The respective capital and operating costs of the Diesel engine, as compared with gas engines and steam turbines, was the chief topic of a very interesting discussion.

COMMERCIAL AIR SERVICE.

Already a good many tons of goods have been carried between England and France and England and Holland, but at the moment the service is small and comparatively insignificant. No one, however, can doubt that the near future will see considerable advancement, both in the type of machine employed and the quantity of goods consigned and carried through the air.

Something of this is forecasted in a book by Mr. Pratt, on "Commercial Airships." This gentleman is chief engineer at Messrs. Vickers, airship department, and therefore should be in a position at any rate to outline future possible developments. He deals with the question, for example, of a Transatlantic service in a complete and detailed manner, working out a schedule and system which might very reasonably be carried out in practice. For example, he suggests a minimum of three ariships for this trade, taking normally 50 or 60 hours for the crossing, so that each ship could, if thought necessary, make two complete crossings per week. It is not, however, suggested that the airships should be called upon to do more than one crossing a week, which would entail in a year 104 crossings—if two airships are used, the other resting—a total mileage of approximately 400,000 miles in 6,500 flying hours.

When it comes down to what can be carried it will be agreed that this is comparatively small. On each voyage 24 tons of passengers, mails and light freight would be taken, the weight of a passenger being estimated at 170 lb., his luggage 100 lb. and food 30 lb. This would mean that 100 passengers would be carried, leaving 10½ tons for light freight.

Mr. Pratt has gone further in his detailed explanation of the scheme, giving figures of total capital required, namely, £2,500,000, which would include airships, mooring towers, areodromes and everything necessary. Working out all the costs, including establishment charges, repairs, maintenance and insurance, he estimates that the cost to a passenger for a single trip would be £77.

The Shell Marketing Co. Ltd. announce that their new but temporary address is Victory House, Kingsway, London, W.C.2. This removal has been necessitated through the delay owing to labour difficulties, etc, which have been met with in the erection of their new building at the foot of Kingsway. They ask the indulgence of friends and customers who may be inconvenienced by the change.

German Engineering Outlook. Herr Becker, managing director of one of the largest of the German engineering establishments, stated at a recent meeting in Berlin that neutral countries have covered their requirements for some time to come in most classes of machinery. Political disurbances in Eastern and South-Eastern Europe put all serious trading with buyers there quite out of question. During the war the engineering industry in Italy, France and Belgium developed very much, and makers are now able to supply the greater part of the requirements of their respective countries, while the remainder is being imported from England and the United States. There are few possibilities, he thinks, of German engineering firms doing business with the latter countries, and both are now competing much more energetically than before the war for trade in the international market. If Germany is to recover anything like her pre-war position in foreign markets, it will be necessary for raw materials to fall considerably in price, for a stop to be put to increases of wages, and for the output of the engineering works to be considerably increased. The abolition of the present export duties on machinery is also essential.

THE TRAINING OF THE BOILER FIREMAN.

By Chas. F. Wade, A.M.I.Mech.E., A.M.I.E.E.

In all the articles that have been written and papers read on the subject of economical steam raising, it is rarely, if ever, the case that one comes across a reference to what is the most important factor of all, that is the human element.

Modern appliances with great potentialities in the way of improved results are installed in boiler houses, whether it be mechanical stokers, economisers, or control instruments of various kinds, yet the results obtained are often most disappointing to the purchasers.

To put the man of much muscular but little mental capacity to operate a boiler plant equipped with the most up-to-date improvements as regards operation and observation is equivalent to giving a village blacksmith a complete outfit of precision tools and expecting him therewith to turn out highly-finished and accurate mechanical devices of all kinds.

It cannot be too often repeated that the economical and efficient production of steam is a highly scientific process, requiring at least an elementary knowledge of chemistry and physics to carry it out with any degree of success. All modern appliances in connection with steam-raising realise this scientific aspect of the question, and therefore need a specially trained man to appreciate their proper usage.

If this fact were more generally realised than it is at present, a certain paper recently read before one of the engineering institutions would never have been written. In the paper in question no reference was made, either in the paper itself or in the discussion that followed, as to the type of man employed.

Non-technical managing directors and owners of works are frantically casting about for methods of reducing their fuel costs, yet for the engineer to suggest to them that they should employ and pay for a better type of man than is the general rule at present is only to invite a snub. The managing director cannot be got to see that there is a great deal more in boiler firing than merely shovelling coal into a furnace and boiling the water to make the steam.

The present writer conscientiously believes that fully 10 per cent of the present fuel consumption used for steam-raising purposes in this country would be saved if a thorough and comprehensive scheme of training were adopted for all boiler firemen, and that a certificate of efficiency was made indispensable for a fireman to obtain a job.

Courses of instruction should be provided at technical colleges for the training of firemen, and at the same time the status of the job should be raised. It is obviously unfair to expect highly-skilled work for little more than a labourer's wage, and carried out under conditions considerably worse than those experienced by the average labourer.

The question of hours of work has also a most important bearing on the subject of "the man behind the gun." One cannot expect intelligence in a workman who has to work continuously for 11 to 13 hours at a stretch, though, of course, there are exceptions to this rule. The average fireman of to-day is quite content to work these long hours so long as they serve to keep his pay packet up to full weight at the end of the week, and in certain districts there

is a strong aversion to the 8-hour shift (three shifts per 24 hours), owing to the reduced amount of pay that will result. On the other hand, the more intelligent minority would much prefer the 8-hour turn.

Take the power station fireman, called upon to work 12-hour shifts for a day or two owing to the absence of the third man. Power station work in the more efficient plants is almost entirely brain work, all the heavy operations being carried out mechanically, consequently, the power house fireman will very soon start grousing about working 12-hour turns in spite of the fact that he benefits financially thereby.

The first essential step to take is to endeavour to attract a better type of man into the work than can be obtained at present. The best way of accomplishing this being, firstly, to pay well and give additional bonus based on the results as to efficiency attained; secondly, to see that the conditions under which the men have to work are reasonably consistent with cleanliness and comfort; thirdly, let all unskilled work, such as sweeping up, removing ashes, etc., be done either automatically or by labourers, and not by the fireman, who should be treated in a similar manner as skilled workers in other trades; fourthly, the working hours should never, except in emergency, exceed eight hours at a stretch.

It would probably be a great benefit to the employer, as well as the employee, if boiler firing were raised to the status of an exclusive and skilled trade, requiring a regular term of apprenticeship and training before the man is considered to be qualified for the position.

It is obviously unfair to the manufacturer of reliable apparatus that can be made to give the best results it is possible to wish for, if these appliances are placed under the care of ignorant attendants who have not the necessary mental capacity to appreciate the possibilities of the plant which they are called upon to work.

Apart from the actual plant, such as mechanical stokers, automatic feed regulators, and the like, the other control apparatus, such as CO_2 recorders, pyrometers, draught gauges, etc., etc., should have their principles clearly explained to the men, who will then be much more ready to trust in and work to the indications given than if the instruments remained a mystery to them.

The whole position may be summarised generally in the statement that, to put modern scientific appliances into the hands of the "old school" type of hand fireman, and to expect high-efficiency results, is equivalent to putting a thoroughbred racehorse under the care of a seaside donkey-boy and expecting the horse to win the Derby.—*Cheap Steam.*

AMERICAN LOCOMOTIVES IN FRANCE. French rolling stock will shortly be usefully increased by 170 American heavy freight locomotives. These were shipped from America just before the armistice, and have now nearly all been assembled, and will shortly be ready for service. As soon as they can be put into use, it will be possible for a similar number of French engines to be overhauled. This has become a matter of urgent necessity, as many French locomotives have not yet been thoroughly looked to after their hard years of war service. Minor accidents, owing to faulty brakes, etc., are becoming increasingly frequent. The new American machines as soon as they are ready will be distributed by the Government among the various French railway companies, according to the latter's needs. Reuter.

STABILITY OF CONTRACTS A BASIS OF INDUSTRY.

How closely the problem of unemployment and the possibilities of obtaining almost immediate amelioration in the serious situation which is rapidly developing is interwoven with the plea for a definite period of industrial stability to facilitate the acceptance and carrying out of large contracts in every industry in the country, was revealed at a conference held under the auspices of the Industrial League and Council, to study this particular question, at the residence of Mr. Hugo Hirst, "Fox Hill," White Knights, Reading.

As is well known, Mr. Hugo Hirst is the guiding genius of the affairs of that vast commercial enterprise The General Electric Co., and when such big employers as he and the others who attended the conference assemble and discuss the situation, with correspondingly important Labour Leaders, to see whether they cannot arrive at some solution and a common ground from which all can immediately begin to make a start, it spells a hope that ere a great while has elapsed the black clouds that are gathering will commence to disperse.

Those who took part in the conference were, in addition to Mr. Hugo Hirst, The Rt. Hon. G. H. Roberts, M.P., The Rt. Hon. R. McKenna, Major-General Sir Newton Moore, M.P., Mr. E. W. Petter (Messrs. Vickers-Petters Ltd.), Mr. David Gilmour (Scottish Miners), Mr. E. Manville, M.P., Mr. John Baker (Iron & Steel Trades' Confederation), Mr. J. D. Boving (Messrs. Boving & Co. Ltd., hydraulic engineers), Mr. Clatworthy (Cardiff), Mr. G. Dallas (Workers' Union), Dr. A. H. Railing and Mr. M. Railing (General Electric Co.), Mr. P. Rosling (Messrs. W. T. Henley's Telegraph Works Co. Ltd.), Mr. Frank Smith (Shipbuilding Trades' Federation), Mr. C. Wilson (Messrs. Osram Lamp Co.), Mr. Jabez Hall (Iron & Steel Trades Confederation), Mr. Pretty (Messrs. Huntley & Palmer Ltd.), and Mr. John Ames, general secretary of the I. L. & Co., etc., etc.

Discussion was opened by Mr. E. W. Petter, who, dealing with the position of affairs from the employers point of view, instanced how disastrous had been the effect of the unrest that had been disturbing industry for the past two years. Employers, not knowing from one day to the next what new demands would be made upon them, were unable to give firm prices to contracts, or even a definite date for delivery, and the result had been that contracts, valuing in the aggregate millions of pounds, had been taken from England and placed abroad. He cited concrete instances of contracts which had been lost to this country through the causes mentioned, and the ultimate result was being reflected more and more by the condition of the labour market. Large employers, who had ventured to state fixed prices in contracts, found, when the contracts had been completed, they had lost thousands of pounds in the transaction. They could not afford to go on doing that. Now, as the contracts in hand are being completed, firms found they had not sufficient work to keep the whole of their plant in operation, and, naturally, they were dismissing men in all directions. Instability and loss of contracts were culminating in unemployment, and the time had arrived when workers and employers

should look the whole situation frankly in the face and see whether they could not find a solution. If they could only agree to stability for a fixed period, approximately 12 months, during which time all should agree to carrying on under existing standards, he had no hesitation in saying the outcome would be that the wave of unemployment would be obviated, industry would speedily recover and absorb the whole of the unemployed in the land, the cost of living would be automatically and materially decreased, and at the end of the year the workers, providing they stuck conscientiously to their work, would find they would be able to maintain, not only their present rate of pay, but its relative value would be considerably enhanced as the value of the pound would be brought considerably nearer to an economic level.

There was a decided unanimity of opinion as to the absolute need for stability, and the only variance of opinion expressed was in regard to the best means which could be adopted to attain that end. That the industries of the country should have an opportunity to compete on sound, stable terms for contracts against foreign competitors was regarded as essential to the welfare of the workers and the nation as a whole, but it was also emphasised and generally agreed that workers should be given a larger share in the management of the industry in which they are engaged, and a proportionate participation in any increased profits derived as a result of the united efforts made.

All the delegates viewed with considerable apprehension the fact that so much land had been allowed to go out of cultivation in England during the last 12 months, and it was urged that every effort should be made to further agricultural development, not only to afford work for the unemployed, but for the primary object of producing food so as to give other industries a chance to export a proportional surpus of their manufactures, and so tend to equalise the rates of exchange.

These conferences of employers and employed, as organised by the Industrial League and Council, were regarded as a useful feature, and the delegates urged the necessity of such conferences being extended to every part of the country.

Use of Dual Valved Engines in Motor Trucks.—The Pierce-Arrow Co., Buffalo, is now fitting its new line of motor trucks with dual-valved engines. It is claimed by the company that the dual-valved engines provide a greatly increased pulling power, with an increase in economy expressed in a greater mileage per gallon of gasoline.—Reuter.

Uniform Overtime. For the first time in the history of the engineering industry in federated shops, uniform conditions for overtime and night shifts have been established by a joint recommendation unanimously made by representatives of the Engineering and National Employers' Federation and the Amalgamated Engineering Union. It is agreed that systematic overtime be limited to 30 hours in any four weeks, and that time-and-a-half rates be paid, with double time rates between midnight and the usual starting hour. If a workman be sent home between midnight and 2 a.m. he will receive double-time rates for the hours worked, and an allowance at the rate of time and a half for the hours not worked, until 6 a.m. A full night-shift week will consist of 47 working hours on five nights, and be paid at the rate of time and a third, and overtime at time and two-thirds, except that double time will be paid between Saturday midnight and Sunday midnight. The agreement will be submitted to the members, with a strong recommendation that it should be accepted.

THERMAL EFFICIENCY IN POWER PRODUCTION.

It has lately become orthodox to maintain that the thermal efficiency of steam turbines is near to the limiting value possible so long as 60 per cent or so of the total heat of the steam is wasted *via* the condensers. There are those, however, who maintain that instead of chasing losses of the order of 1 per cent or 2 per cent, we might be better employed in securing wholesale improvement in efficiency by radical changes in practice.

One method of so doing is by utilising exhaust steam for heating purposes. The "district heating" practice of America might well be imitated in this country for industrial heating purposes, if not for heating offices and residences. It appears seldom to be realised that no super-station can compete in total costs with the smallest isolated power plant if the latter can utilise its steam for heating purposes. *A fortiori*, since power production in itself is conducted much more efficiently in bulk, it behoves central stations to deal actively with the exhaust heat problem. No super-station should be erected where its exhaust heat cannot be utilised, otherwise it will undoubtedly be unable to compete with the smallest power station which finds a market for its low-temperature heat units.

Another and quite different method of improving the overall thermal efficiency of power production is proposed by Prof. Konrad Baetz, who developed his theories and conducted numerous experiments during nearly 20 years at the German Engineering School for Chinese, at Shanghai, until this work was brought to an end by the war. In announcing his results in a brochure published by Otto Spamar (Leipzig), Baetz gives an exhaustive mathematical treatment of his theories and a complete statement of his practical results, the latter being admittedly incomplete. As will be appreciated from the following general particulars, the matter is one deserving the attention of every turbine engineer.

Broadly, the proposal is to combine the working of a reciprocating engine and a turbine in a single machine by the continuous filling and emptying of cells in a rotating wheel. For instance, the rotor may run inside a stator system which is devided by a horizontal partition. In the upper part of the stator high-pressure steam is fed through guide blades to dead-end cells in the rotor. The cells are thus filled with compressed steam which escapes and imparts a further impluse to the rotor, when the cells reach the lower half of the stator in which a vacuum is maintained.

The actual arrangement proposed is considerably more complex, but is fundamentally the same. The entering and emerging steam acts as an almost friction-less piston on the remaining contents of the cell, and the steam entering and leaving at the periphery acts as in action and reaction turbines.

Baetz contends that these two actions are not identical, but that they are additive, the reciprocating-engine effect being proportional to the product pressure x volume-change, while the turbine effect is proportional to the product volume x pressure-change. In the cell considered there is simultaneous volume-change under pressure and pressure-change under mass-acceleration. The working medium in

gas and steam turbines is elastic, and pressure layers may be formed in it without serious energy loss. In this respect, Batez's theories and apparatus seem to have points or resemblance with wave-power transmission, which should certainly repay investigation. The author maintains that the continuous filling and evacuation of rotating cells constitutes a distinct thermo-dynamic process, the theory of which he develops at length. In so doing he reaches the conclusion that power transfer to the blades of an ordinary turbine depends, not so much on the gradual deflection of the fluid-stream, as on pressure differences in the fluid caused by retardation of the mass of the latter. In the same way, pressure differences in the cells of the new turbine add to the driving effort.

The design proposed makes possible the construction of steam turbines of very small dimensions, and as low speed as may be desired. Within wide limits the power developed varies only slightly with the revolutions per minute. Very important advantages are anticipated from the application of the system to gas turbines and other internal combustion turbines. German patent No. 280,083 sets forth the author's proposals in this connection. Valves are eliminated, and it is claimed that abnormally high efficiency is obtained whilst avoiding burning due to excessive temperature.—*Electrical Industries.*

COMPANY NOTES.

KAYSER, ELLISON & CO.—This Sheffield steel-making firm has had a slightly less prosperous year, and the dividend is consequently reduced from 9 per cent to 8 per cent, in both cases clear of taxation. For each of the three years to June, 1918, the ordinary shareholders received 20 per cent, free of tax, to which was added in respect of 1917-18 a bonus of 100 per cent out of the reserve fund. The dividend now announced is equal to 16 per cent on the old capital. Three years' results are appended:—

	1919-20.	1918-19.	1917-18
Profit	26,309	28,932	30,588
Brought forward	10,502	9,070	20,482
Available	36,812	38,002	51,070
Preference dividend	6,000	6,000	6,000
Ordinary dividend	20,000	21,500	21,000
Benefit fund	—	—	5,000
Reserve	—	—	15,000
Carried forward	10,812	10,502	9,070

The profit in 1916-17 was £38,671, in 1915-16 £38,121, and in 1914-15 £28,540.

By the first week in November the London business of Sir Isaac Pitman & Sons Ltd., will be transferred from 1, Amen Corner, E.C., to Parker Street, Kingsway. Pitman House is a large and commodious building, suited to the requirements of an expanding business; for, within the last two years, this firm has amalgamated with itself those of Whittaker & Co. and Selwyn & Co., and has also taken over a number of the technical and artistic publications of John Hogg. A feature of its new head quarters is the Library, a handsome room where visitors desiring to examine Pitman books will be welcomed.

QUEENSLAND AND AUSTRALIAN ENGINEERING.—At present there are two big iron and steel works in the Commonwealth, and an important advantage to the engineering resources of the Commonwealth will be made when the Queensland Government establishes its large works at Bowen, in the vicinity of which ample supplies of coking coal are available. The capacity of the first plant will be extensive, as may be judged from the following essential appliances included in the installation:—One blast furnace plant, to produce 350 tons of pig iron per day, with hot stoves and complete blast furnace equipment; also slag cement plant attached. One battery of by-product coke ovens to supply coke, both for the blast furnace and also for sale purposes. Four open-hearth steel furnaces, each of 60-tons capacity; and a hot metal mixer of 500-tons capacity, both fitted with the most modern equipment.—*The North Queensland Register.*

Trade Items, Notes, &c.

HAMWORTHY OIL ENGINES.—A neat catalogue, well illustrated, shows various combinations for these oil engines, with a brief description of each. It is claimed that they are simple, reliable, and cheap. Hamworthy engines can be supplied for fixing on foundations, for driving any class of fixed machinery, or they can be mounted on skids in order to render them suitable for carrying to any machine requiring power. They can also be supplied as portable engines, on wheels, for general purposes.

ELECTRIC HARBOUR GANTRY CRANES FOR COLD STORES IN ITALY.—Cranes are wanted of the type shown on a sketch which has been received, and may be examined at the Department of Overseas Trade, on application to Mr. Dempster (Room 50). Load to be lifted on the single end of the chain: 1·5 metric tons. Total lifting height: 22 metres. Radius from centre line of gantry: 12 metres. Height of hoisting pulley on rail level: 18 metres. Hoisting speed: 0·60 metres per second. Slewing speed at the end of the jib: 1·65 metres per second. Opening of gantry (between centre lines of legs): 4 metres. Distance from centre of outside leg to edge of wharf: 3·35 metres. Power available (three-phase current): 260 volts, 42 cycles. The cranes are to be used to discharge frozen meat and lard from vessels, and to lay it either on the wharf, or on the railway wagons, or on landing places at the various floors of cold stores. The highest floor is 10 metres above the wharf level. Commercial Secretary, H.M. Embassy, Rome, will supply any further information.

STANDARD MOTOR TRUCK CO. CUTS PRICES.—The Standard Motor Truck Co., of Detroit, Michigan, producing more than 3,000 trucks a year, is the first of the quality trucks to announce a reduction in prices. The new prices on the four models, to be effective as from October 1st, are 2,250 dols. for the 1-ton model 1K, reduced from 2,475 dols.; 3,100 dols. for the $2\frac{1}{2}$ ton, which was 3,520 dols.; 4,000 dols. for the $3\frac{1}{2}$ ton, which was 4,410 dols., and 4,800 dols. for the 5-ton, which was 5,250 dols. "This reduction was made to assist in the country-wide movement to reduce prices," said Mr. F. J. Fisher, secretary and treasurer of the company, "and will not have any effect on wages. We do not want to pose as philanthropists when we tell you that this action was taken in spite of the fact that all but two of our sources of supply informed us that they could foresee no reduction in their prices. But we sincerely believe that this is the only way of ever bringing prices back to a normal basis, and we anticipated that our other sources of supply will soon join this movement."

CHINA'S SURFACE COAL.—Mr. Alexander Grant, a London mining engineer, informs a daily contemporary that China possesses vast territories containing an unlimited quantity of workable coal and iron that can be exported at a very cheap rate. "My name," declared Mr. Grant, "has recently been associated with a shipment of coal to Newcastle from China. As a matter of fact, I had nothing to do with this particular shipload. It was shipped for the purchasers by the Canadian Pacific Ocean services. I myself have been prospecting and exploring in connection with coal and iron for 20 years, but since 1913 I have been particularly attracted by the enormous possibilities of China in this direction. That country has been exporting coal to France for 12 months. At present China is exporting about 7,000,000 tons of coal per year. In giving the following rough estimates I am not speaking by the book, for my figures have to be kept later, so they must be taken as approximating in all cases. China has 1,000,000,000 tons of workable iron in sight, so to speak, but the quantities of coal easily workable are vastly greater than that calculation. Her tracts of coal are in fact unlimited. How easily workable the coal is may be seen by my statement that the maximum depth of this surface coal is 400 feet. The economic value of this coal can be easily appreciated when I say that the working pit-mouth cost of the coal is 2s. a ton, as against our home coal cost, which is about 14s., I believe, a ton. Some people have thought oil would displace coal, sooner or later, when the miner's occupation would be gone. But oil can never do this while China possesses all this cheap coal. The only factor preventing an enormous extension of Chinese coal exportation is the shipping factor. There is no necessity to employ much machinery or coal-cutting machines of any kind there owing, of course, to the tremendous amount of cheap labour available."

AMERICAN ENGINEERING NOTES.

THE situation in this country during the first seven months of this year is worth recording if only to be compared with your own. In that period the per ton value of our bituminous exports was 7·29 dols. for the 9,365,491 tons sent overseas, while the value f.o.b. mine was 6·73 dols. a ton. On the other hand, during the same length of time Canada bought 6,074,537 tons of our soft coal for which she paid only 5·07 dols. per ton. We are told that during the same period English coal export prices ranged between 25·20 dols. and 28·80 dols. a ton. No wonder we had the business if these latter figures are correct. Is it?

However, as the world must have fuel, and English exports being so far below the pre-war tonnage, our hold seems to be getting firmer. About the only serious obstacle we have to overcome before being able to increase our exports and hold them is to largely increase the number of coal freight cars. Our soft coal producers say very confidently that given a sufficient number of cars they can dig 12,000,000 tons of soft coal a week, which will provide a huge exportable surplus.

F. G. Cottrell, the Director of the U.S. Bureau of Mines, speaking of the new monarch of motion, says that the production of gasolene has increased from around 13,000.000 barrels in 1909 to almost 99,000,000 barrels in 1919, or 660 per cent. While in the same period, it is estimated that the number of automobiles and trucks have increased over 1,700 per cent.

I learn from *Oil News* that in a recent test at Erie, Pa., an electric locomotive pushed two steam locomotives off their feet—perhaps it would be more correct to say "off their wheels."

The test was to determine the relative powers of the big monsters. Two of the largest steam locomotives of the Erie Railroad were coupled up and headed against the electric giant. Steam was turned on in the locomotives and "juice" given the electric. The electric pushed the old timers along a stretch of track with both their throttles wide open and driving wheels working their utmost to help them hold their own. The electric engine used is said to be the most powerful in the world. It is 78 ft. long, 17 ft. high and weighs 265 tons. It has 14 axles, 12 for drives and two for guides. It is designed for hauling in actual service a 12-car train of 960 tons trailing against a grade of 2 per cent at 25 miles an hour. It is so designed that in coasting down grades it generates electric current which is sent back into the line to help other trains up the hill.

The Super-Power Survey, a semi-official organisation, plans to develop all available water powers in connection with great steam power plants located at or near the coal mines, and pour the product of the hydro and steam plants into a great trunk-distributing system with the view of lowering the cost, while absolutely guarding against railroad or mine failures in the future. A gigantic undertaking. But since the war hardly anything seems impossible.

My friend O. P. Austin, statistician of the National City Bank of New York, says that the railroads of the world are now turning to the United States for material with which to renew and enlarge their working plants. Our exports of railway material in the fiscal year 1920 aggregated over 150,000,000 dols. in value, as against 80,000,000 dols. in 1918 and 25,000,000 dols. in the year before the war.

Necessarily, the world's railways "marked time" to a very considerable degree during the war, especially in new construction. Even in our own country the number of miles of road constructed in the six years since the beginning of the war has been little more than that of certain single years during the period of our active railway construction. In Europe the construction of new roads was, of course, limited by war demands, and in many cases the destruction far exceeded the construction. In other parts of the world which had relied chiefly upon Europe for financing new construction and supplying materials therefor the industry of railroad building came also to practically a standstill, and the world's railway mileage emerged from the war period showing but a small percentage of gain over that at its beginning.

It is not surprising then to find that our exports of materials for railways in 1920 are six times as much in value as in the year preceding the war. Indeed, the grand total of material exported for railways would probably approximate, and perhaps exceed, 200,000,000 dols. if complete figures could be obtained. In certain lines such as steel rails, other track materials, locomotives and cars, both freight and passenger, exact figures are available, but it is not practicable to determine what proportion of the 25,000,000 dols. worth of structural steel or the 50,000,000 dols. worth of metal-working machinery exported in 1920 was for the railways. In locomotives alone the total exports in the fiscal year 1920 amounted to 43,000,000 dols., against 25,000,000 dols. in 1919 and less than 4,000,000 dols. in the fiscal year 1914, all of which preceded the war. Of steel rails the total for 1920 was 32,000,000 dols., against 10,000,000 dols. in 1914, and of other track materials, including "frogs," switches, spikes and tiles, exported in 1920, 12,000,000 dols. against approximately 5,000,000 dols. in 1914. Railway cars for freight purposes show very large totals in the exports of 1920, 54,000,000 dols., against 13,000,000 dols. in 1918 and 5,000,000 dols. in 1914.

Mr. James A. Farrell, President of the United States Steel Corporation, is one of the most active as he is also one of the "heavyweights" in promoting and encouraging in every way America's export trade. He hits straight from the shoulder, as a man who has come up through the works on his own is expected to do. He hits out now by telling us that unless we hold a big foreign trade we are in for a bad time, and that just talk won't stave it off. I thought he put the matter in a nutshell when he told the meeting of the National Foreign Trade Council :—

"In every business (American) there is a part of the production, roughly estimated as the last 20 per cent, which cannot remain unsold if the first 80 per cent of the sales are to prove profitable. Remove this last 20 per cent and the whole operation will cease to show a profit."

. . . "So it is with the United States; a certain volume of foreign sales must be maintained, or the industry of the country will suffer throughout."

One of the very elementary truths that not 5 per cent of our people seem to understand, we being in the kindergarten of the international export school.

One of our important leather merchants takes a gloomy view of the leather industry. He asserts that tanners are only using enough hides to keep their tanning liquor from souring.

Samuel Gompers, veteran President of the American Federation of Labour, has come out strongly with respect to the position of British labour regarding revolutionary effort. He characterises the pleas of the International Federation of Trade Unions to prevent war by refusing to work in enterprises aiding war as "appeals to revolutionary violence," and he states emphatically that the American Federation of Labour is diametrically opposed to such methods.

Wm. H. Barr, President of the National Founders' Association, puts our railway labour situation thus tersely :—

"The present demands of the railroad unions are part of a plan to promote the nationalisation of the railroads. For example, under their plan, piecework in the shops would be abolished, and this would mean a decrease in production of from 25 to 40 per cent. Another phase of the demand is the fact that in the car shops, for example, no man, however qualified, can be taken on except as an apprentice, and he would have to serve four years before he would be accepted as a full-fledged worker. Do not under-estimate the significance of that proposal. Let us assume that in a shop there is deliberate slacking by a dozen men. Under the centralised control, the railroad, if it dismissed these men, would be compelled to appear and state its reasons, and the men might be reinstated. If they were not reinstated, the railroad could not take on new men because of the scarcity of expert workers qualified under the union rules, and even if it took on absolutely expert outside workers, they would merely rank as apprentices and would not be permitted to do the work which the dismissed dozen had been doing. The plan is diabolical in its ingenuity, and is the direct result of the fact that when the Government took over the railroads it violated its promise to return the roads just as they had been taken over. The roads were plunged into a physical and financial turmoil, but, worse than all, was the fact that nearly every railroad was completely unionised. This unionisation is resulting now in the determined effort of these unions to take from the hands of railway officials the power of discipline, and who shall say that it is not a plan to demoralise the railroads and bring about a return to Government control or ownership."

FOREIGN NOTES.

Proposed Purchase of Ice-Breaker for Sweden.—A well-known Swedish engineer has sent a communication to the Board of Trade proposing the purchase of a large ice-breaker, originally ordered for Russia, now lying at Vickers', in Canada. The ice-breaker in question is a very large one, about 300 metres long, and equipped with engines of 8,400 H.P. The price is reported to be £250,000.—Reuter.

A Turbine Locomotive: Experiments in Switzerland.—A message from Zurich states that a locomotive fitted with a steam turbine, the invention and construction of a Swiss firm, has recently been undergoing its trials between Romanshorn and Winterthur. It has given excellent results, drawing as much as 400 tons, and it is, moreover, claimed that it shows a considerable economy in fuel, 30 to 40 per cent less coal being used than is burned by ordinary piston locomotives.—Reuter.

The Growing Importance of Hydro-Electricity in Spain.—According to statistics drawn up by an expert, the power represented by existing hydro-electric installations in Spain is as follows: Plants of 800 H.P. and over, 577,192 H.P.; 300 H.P. to 800 H.P., 28,162 H.P.; less than 300 H.P., 13,402 H.P.; a total of 618,756 H.P. Plant under construction, reckoning only those exceeding 5,000 H.P., represent an additional 259,000 H.P., and the demand for hydro-electric concessions is always considerable. The output before the war was only 150,000 H.P., and the prospects of hydro-electricity are considered to be very bright.—Reuter.

Electrical Industry in Germany.—For some time now the position of the electrical industry in Germany has been steadily growing worse. Orders have decreased by 50 per cent and more, many electro-technical articles no longer finding buyers. Worst of all is the situation of the cable industry though trade in conductors, small motors and installations in general, is not much better, as the central stations no longer undertake renewals or extensions of their works because of their fear of the socialisation of industries. As the financial situation of most tramway companies is very unfavourable, business prospects in this field also are very bad. The glow lamp industry boasted of exports to the amount of 50 per cent of output before the war, but they have now fallen to 25 per cent, and the decline is still going on. The prices of German electro-technical products have now nearly reached those current on the world's market, and some have even exceeded them. The manufacturers, therefore, are demanding the abolition of the export duty. Deliberation have lately taken place at the Foreign Trade Office (Aussenhandelsstelle), for electrical products in the presence of representatives of the Government, of the Chamber of Commerce and of the manufacturers, with regard to the control of and duties on exports. The director of the Export Office for electrical products tried to prove that, by introducing the control of prices charged for exports of electro-technical products, a milliard marks more had been realised. It was then decided that the abolition of the export control should not be recommended for the time being. In the middle of August the export duty on a great number of electrical products, previously 6 per cent to 8 per cent was reduced to between 1 per cent and 5 per cent. The bad state of the electrical industry was made obvious at Leipzig Technical Fair, which this year began a fortnight before the general fair. The number of exhibitors rose to 3,400, but business was very poor, the failure being due to the generally unfavourable situation and high prices. The exhibitors mentioned as a further cause, the separation of the technical fair from the general fair, and urged, at a protest meeting, the reunion of the two fairs. A good many exhibitors left their goods for show at the general fair now being held. Foreign business was particularly bad. At the last technical fair in the spring, 300 Swiss purchasers attended, whilst they numbered 38 only this time. With the present rate of the German exchange there is no longer any possibility of cheap purchases in Germany, and, in addition, expenses are very high. The unfortunate experiences of many firms doing business with Germany, the unfair business methods of certain German manufacturers, especially the non delivery of firmly ordered and pre-paid goods, the subsequent arbitrary increases of prices and the complicated time-wasting official control of exports appear, however, to have been the main obstacles to the attendance of foreign buyers at the fair.—Reuter.

Wireless Telephony in South Africa.—In March of this year the Wireless Agency Ltd. erected for demonstration purposes Marconi wireless telephone-telegraph sets at Rosebank and Paarl. Successful speech communication was established, and its quality was generally remarked upon. At the end of the Rosebank Show the sets were transferred to Johannesburg and Pretoria respectively, and speech communication was established between the show grounds at Johannesburg and the Railway Institute, Pretoria. On this occasion, certain phenomena were observed, and it was found that communication, although good, was improved when the Pretoria Station was moved from the Railway Institute to a spot just in front of the Union buildings. Notwithstanding the fact that the total distance between the Pretoria station and the Johannesburg station was thus increased by two miles, it is believed that the improved communication was due to avoiding the screening effect of the high ore-laden hills with which Pretoria is surrounded. It was also found desirable to institute variable tuning adjustment in order that the particular set could be operated equally well in any part of the Union and under various conditions. When the Show-week was over the Johannesburg station was moved to the aerodrome. In both instances, even before the removal of Pretoria station, good speech communication was obtained. The violence of the thunderstorms in South Africa are, however, proverbial, and, like its sister service, the land telephone, wireless telephony had to be closed down when thunderstorms were taking place immediately overhead. The aerodrome site gave better results than the Show-ground site, because the only available position in the Show-grounds left the stations surrounded by high trees at a distance of only a few feet from the aerial, and the earth had to be made on hard rock. It will be recalled that Sir Harry Lauder sang on the wireless telephone from Johannesburg to Pretoria, and that wireless telephonic speech was received at the *Star* office from one of the South African Aerials Transport Co.'s aeroplanes whilst in flight. When the wireless telephone sets were brought back to Cape Town, a large number of demonstrations were given of transmission of speech between Cape Town and Simonstown. In this case the stations were so arranged that Table Mountain, with its huge mass, intervened. Excellent speech communication was obtained, and continuously satisfactory demonstrations were carried out over a period of several weeks. Included in this series of demonstrations was the farewell song by Mr. Frank Wignall to the Governor-General on the occasion of his departure in the "Llanstephan Castle." The cable ship "Britannia" heard excellent speech at a distance of over 220 miles from Cape Town, and a small aircraft transmitter installed at the office of the Wireless Agency Ltd. was heard at a distance of over 110 miles by the same vessel. Wireless telephone communication has now been established between Cape Town and Saldanha Bay. Speech on the small 1/7 H.P. transmitter installed in the office of the Wireless Agency Ltd. is all easily readable at Saldanha Bay. During the course of demonstration much valuable data was collected, from a consideration of which certain recommendations entailing slight modifications were made to Marconi's Wireless Telegraph Co. Ltd. These demonstrations were approved, and it is now understood that any sets which may be supplied to South Africa will embody these modifications. This does not affect the main principle, however, that demonstrations conducted with the sets which are still in operation have proved that the wireless telephone is a sound commercial proposition in South Africa.—Reuter.

Reviews.

Hyatt's Ltd., Devonshire Street, London, W.C.1, have sent us a new catalogue relating to their roller bearings and illustrating their standard fittings for line shafting. It is profusely and well illustrated. There are line sketches as well as sectional views. It is contended that the installation of roller bearings on line shafting results in a considerable saving in fuel. The bearing consists of an outer steel race secured in a suitable housing, and the rollers are designed to work direct on a plain steel shaft. The roller is a distinctive feature, and is made by the spiral winding of a high carbon fatigue-resisting alloy steel strip to a cylindrical form which gives great strength, resilience and flexibility. Tables of power capacities for shafting and of standard dimensions for drop hangars, wall boxes and brackets, etc., are given, while there are many useful hints for fitting-up, oiling, cleaning, etc.

New Companies.

Fairless Electric Weldings Ltd.—Private company. Registered October 25th. Capital £10,000 in £1 shares. To carry on the business of electric, oxygen and acetylene welders, ship repairers, mechanical and electric engineers, machinery manufacturers, tool makers, etc. The first directors are: G. P. Fairless and C. Henson. Qualification: £200. Secretary: G. P. Fairless. Solicitor: A. H. Parkin, 77, High Street, Stockton-on-Tees.

Alpine Motor Co. Ltd.—Private company. Registered October 25th. Capital £50,000 in £1 shares (25,000 "A" ordinary and 25,000 "B" ordinary). To acquire the benefit of an agreement contained in a letter to C. Jarrott, H. W. Sidley, H. Temperly, and A Bray from the representative of the Oesterreichische Waffenfabriks Gesellschaft, and to carry on the business of manufacturers, repairers and storers of, agents for and dealers in motor cars, vans, lorries, vehicles and boats, flying machines, etc. The profits of the company are to be applied first in paying 9 per cent non-cumulative dividend on the "A" and "B" ordinary shares (free of income tax), and the balance (if any) is to be placed to reserve fund until such fund amounts to and is maintained at £25,000. The subscribers are to appoint the first directors. Qualification: £100. Remuneration: £500 each per annum. Solicitor: T. A. L. Whittington, Prudential Chambers, Neath.

Sturminster Newton Motor Works Ltd.—Private company. Registered October 25th. Capital £1,500 in £1 shares. To take over the business of a motor and engineering works carried on by F. G. Ingram at Sturminster Newton, Dorset, as the "Sturminster Motor and Engineering Works." The permanent directors are: O. L. Denney and J. A. Earle. Secretary: J. A. Earle. Registered office: Station Road, Sturminster Newton, Dorset.

Mortgages, Charges, Satisfactions.

Lever Manufacturing Co. Ltd.—R. F. Frazer, of 41, North John Street, Liverpool, ceased to act as receiver or manager on October 25th, 1920.

Wellman Smith Owen Engineering Corporation Ltd.—Particulars of £30,000 debentures authorised October 14th, 1920; whole amount issued; charged on the company's undertaking and property, present and future, including uncalled capital.

Engineers' Club Ltd.—Mortgage dated October 21st, 1920, to secure £20,000, charged on Bridgewater Chambers, Manchester. Holders: Refuge Assurance Co. Ltd.

James Evans & Co. (Manchester) Ltd.—Mortgage dated October 20th, 1920, to secure £3,300 charged on Britannia Iron Works, Salford, and a yearly rent charge. Holders: The Misses F. I. T. Robinson and R. Robinson, Monton Holme, Eccles, near Manchester, and H. P. Bedell, 24, Cross Street, Manchester.

W. Brearley (Rochdale) Ltd.—Debenture dated October 8th, 1920, to secure £1,200 charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Buttery, Sunnyside, Lorden, near Rochdale.

Briggs & Powell Ltd.—Mortgage dated October 9th, 1920, to secure £1,500, charged on certain properties in Beverley, Yorks. Holder: W. H. Briggs, Beverley.

Patent Applications.

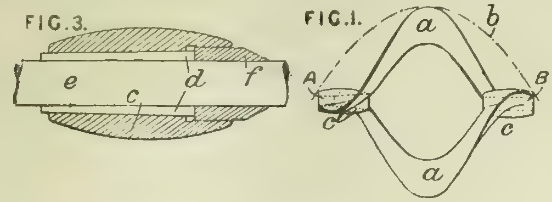
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

SCREW PROPELLERS.

144,448.—J. I. THORNYCROFT & CO., 10, Grosvenor Place, Westminster, and SIR J. I. THORNYCROFT, Steyne, Bembridge, Isle of Wight.—May 8th, 1919.—A propeller for navigable vessels adapted to ride over obstructions, such as booms, comprises helical blades *a* which are secured at their ends to two independent bosses *c*, *c1* mounted on the propeller shaft. The enveloping surface swept out by the screw corresponds to that swept out by a parabola *b*, and the distance A B between the ends of the screw is greater than the maximum diameter of the screw. The blades have no free ends. The forward boss *c* is tapered internally and secured to the shaft *e* by a tapered split bush *d* which is forced

FIG. 3. FIG. 1.

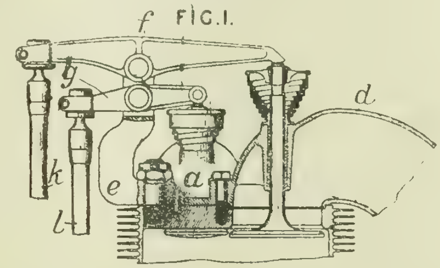


into position by a nut *f*. Each half of the bush *d* may be splined to the shaft. The rear bush may be fixed to the shaft in the usual way.

INTERNAL-COMBUSTION ENGINES.

132,827.—G. E. BRADSHAW, and A. B. C. MOTORS LTD., A. B. C. Motor Works, Walton-on-Thames, Surrey.—May 16th, 1918.—In

FIG. 1.



order to keep the cylinder head of air-cooled engines at an equal temperature throughout, the cooling-air current meets the exhaust valve casing *a* before the admission valve casing *d*, and the valve-rods *k*, *l*, levers *f*, *g*, and the pillar *e* are all in one plane, the pillar being of stream-like section, so as not to obstruct the air current. When a single exhaust valve is used, there are two lateral outlets from the casing and the valve-spindle guide is supported on a tripod.

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[*When enquiring of Advertisers will readers kindly make a "special point" of mentioning* THE INDUSTRIAL ENGINEER.]

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CONTENTS.

EDITORIAL.

THE OPEN SHOP.

ONE can hardly conceive the institution or return to the state of the open shop in this country, and probably we shall never see it. But, with increased educational propaganda, there is no doubt that there will be a greater tendency towards closer industrial relations between employer and employee without the interference or control of the labour unions. Recently, Mr. Winston Churchill stated that while admitting the beneficent influence which labour unions had exercised for so long in British public and industrial life, he thought that the trade unions would have to review their position very carefully in the next few years. He further said that there was a very active and voluble minority always trying to obtain control of the organisation, and the definite and avowed intention of this minority was to reck the whole system of society by any means, however violent and wicked that might be, within their reach.

In other words, Bolshevism pure and simple. Surely it must be recognised that the future prosperity of this country depends absolutely upon the success of our industries. Labour in the past has been led, and, in many cases recently, led very badly indeed. There is no true appreciation of values, with the result that we are often faced with unofficial strikes, ca' canny method prevails, and production—which, as has been pointed out by the true labour leaders, can save us—falls below the possible minimum.

In the United States there is a very definite campaign progressing in favour of the open shop. It has made such headway that the trade union leaders are sitting up and taking notice. When the writer was in the United States at the back end of 1919, it was his privilege to attend a meeting of business men at which this very question was discussed. The most forcible arguments were brought forward in favour of the open shop, and it was clear from the extremely determined attitude of large employers of labour who were present that the campaign, which had already been started, would not lack support of the most extreme character.

Considerable propaganda work has been undertaken, and it is extremely interesting to note that there is a rising tide of sentiment and activity in favour of the American employment plan, or, in other words, the open shop. The arguments advanced urge the working men and women to reason it out for themselves from the economical view point, and independent of all influences except their conscience and the constitution. This the employers hope to inspire and stimulate by discussion, believing firmly in the justice of their position and confident that they have a better argument than the leaders of the trade unions, who have told the workmen that without the closed shop trade unionism is a dead issue.

What is the chief aim in the harmonious relationships it is hoped to establish? The American association's principle is " A fair day's pay for a fair day's work, and a fair day's work for a fair day's pay." In this country recently, although more than a fair day's pay has been asked, and in many cases secured, we have by no means had the fair day's work.

The notices issued to employers is interesting. At one point it states: " It is unnecessary for any employee to join a labour union to hold a job in this department. This firm will continue to maintain the open shop policy in our industrial relationships with our employees." Then, again, and more to the point: " We disavow any intention to interfere with

the legitimate functions of labour unions, but will not admit of *any outside interference with the management of our business.*" Individual rather than collective bargaining is proposed. One very pregnant statement, which it would be well to emphasise very strongly over here, reads: "The management of this firm is directly responsible for the work turned out by our employees, and we reserve the unrestricted right to designate and select the employees whom we consider competent to perform our work, and to determine the conditions under which that work shall be performed. The question of the competency and compensation of our employees rests entirely with us and will remain in the hands of this firm."

The following principles adopted by Indianapolis employees are worth quoting:—

(1) We believe in harmonious industrial relations between employer and employee, and that the latter shall receive adequate compensation and timely advancement for his service measured by his individual efforts. We shall not countenance any employer who does not pay a fair day's wage for a fair day's work, nor any employee who shirks a fair day's work for a fair day's pay.

(2) We are unalterably opposed to the principle of the closed shop. It is unAmerican, illegal and unfair to the independent workman who does not desire to join a union; to the employer who prefers to operate an open shop, and to the public. Therefore we shall defend the right of every workman to be free to dispose of his time and skill advantageously, and we shall maintain the right of every employer to conduct an open shop.

(3) We are strenuously opposed to lock-outs, strikes, sympathetic strikes, boycotts and kindred evils. We will resist those selfish interests, which through coercion, false statements and violence disrupt the relations of peace and unity existing between the just employer and his employees.

(4) Law and order are essential to the commercial progress and development of any city. We pledge our support to the properly constituted authorities for the impartial enforcement of law and the strict maintenance of order at all times and in all places, so that our community may enjoy its consitutional and inalienable right to peace, liberty and security for life and property.

The fact that the movement is growing rapidly throughout the United States is worthy of the closest consideration. If it continues to grow the result will be a real competitive menace to our trade—still lingering under the handicap of trade union stringencies. It is a new phase that we cannot ignore, and we should closely watch further progress of the scheme. If the true ideals of the open shop are secured the productive capacity of each individual plant will enormously increase. No one surely refuses to pay high wages if adequate production is given, and, undoubtedly, the American workman will benefit equally with the employer.

Double Track Roads Suggested.—Addressing the members of the Institution of Civil Engineers, the President, Mr. J. A. Brodie, said road vehicles could be used in future to an immensely greater extent than at present for transport between the factory and the shop. He suggested a minimum width for double track roads of 150 ft. with, perhaps, 180 ft. between the fences.

CHINESE RAILWAY CONFERENCE: IMPORTANT DECISIONS.

The Peking correspondent of the North China *Daily News* reports that the Commission of Chinese and foreign engineers appointed by the Ministry of Communications to consider the standardisation of China's railways, has closed its third session after arriving at many important decisions.. The conference was opened on September 13th by the Minister, Mr. Yeh Kung-cho, who inaugurated the work of standardisation by unifying the system of railway accounts some years ago. The meetings were attended by British and American engineers and by Chinese engineers and officials from every Chinese railway.

One of the most important decisions of the Commission during the recent sessions was the adoption of the metric system. A score of other features were also agreed upon, such as the specification of a standard gauge, a standard clearance, standard measurements and weights of cars, standardisation of curves in construction, standardisation of brakes, couplings and other appliances, and of the specifications for many features of the locomotive.

The one question taken up for which no standard specifications were agreed upon was that of steel for bridge construction. In the manufacture of such steel British and American practices differ materially. The stock British product for the manufacture of which British mills are especially equipped is a hard, high tension steel. The American product is a softer, more resilient steel. British and American engineers always differ upon the question of whether it is better to have steel that will bend before it breaks or steel that will break before it bends. If the Chinese were to decide to adopt either formula for steel manufacture, it would mean that they would confer upon either British or American manufacturers a monopoly upon the sale of steel to China, because it would be too expensive for either to undertake to manufacture according to the other's formula to fill a Chinese order. It was anticipated that there would be a keen debate upon this matter, and it was believed that the Americans would have a slight advantage through the precedent created by the Yangtze Engineering Works, which uses the American formula in the manufacture of bridge steel.

As it happens, however, there has been no dispute, and bridge steel is not standardised except that it is suggested to the Chinese that when American steel is used presumably on an American built line, it should conform to the American official standard in quality, and that the same conditions should apply to British steel. The choice of materials in each case is left to the Ministry. This was the case in which no compromise was possible and in which any decision would have ruled either America or Great Britain out of this particular market.—Reuter.

Cammell, Laird's and Beardmore.—Arrangements are stated to be in progress for the acquisition by Cammell, Laird & Co., Birkenhead, of Beardmore & Co., Glasgow. Lord Pirrie, it is reported, will be chairman of the new company. Recently he acquired a controlling interest in the Ardrossan Harbour Co., Clyde. Establishments in which he is interested include Harland & Wolff, who have yards at Govan and Greenock.

DROP FORGING.

By P. Rowley, B.Sc.

(*Continued from page 16, November 8.*)

Troubles Due to Design.

Much valuable time is often wasted owing to designers having insufficient knowledge of the essential requirements in a drop forging and the manufacture of the dies. They appear frequently to take the view that the plastic metal flows into the cavities formed in the dies. In casting no doubt the molten metal does flow from two or more directions to the centre and form a solid mass on cooling, but the

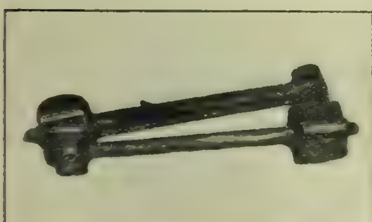


Fig. 12.—Cracks in Connecting Rods due to Runs.

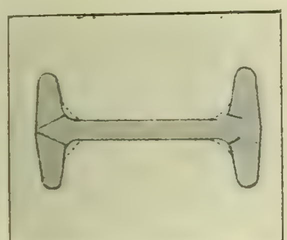


Fig. 13.—Diagram showing Runs in H Sections.

plastic material used in drop forgings cannot do so owing to oxidisation and decarburisation of the exposed surfaces.

For instance, in the case of a connecting rod of the orthodox H section, the designer, in cutting down the weight, designs the rod with a very small radius in the corners of the flutes, and the result is that the metal from the central web tends to flow out into the scrap, while that from the sides also flows to the scrap, causing cracks running from the radius to the edges of the fin or scrap, or else a decarbonised streak (Figs. 12 and 13). The run might be very small or, on the other hand, it might actually break through the sides of the rod, but in either case a defect was produced, which could not

Fig. 14.—Beading on Brake Shoe broken by Metal Running into the Scrap.

be attributed to the bad workmanship of the operator. The obvious remedy is to provide a large radius so that the metal may run into the sides of the H section before flowing into the flash.

Fig. 14 shows a brake shoe stamping, the beading of which has broken through owing to the metal rushing into the scrap, which is almost exactly a parallel case to that quoted above.

Wherever possible, especially in the case of levers, a fish-back design should be used instead of the orthodox H section, thus reducing both the forging difficulties and those connected with the die sinking. In cases where nickel chrome steels are forged into similar sections, defects are produced due to the bottom half of the die cooling of the work more

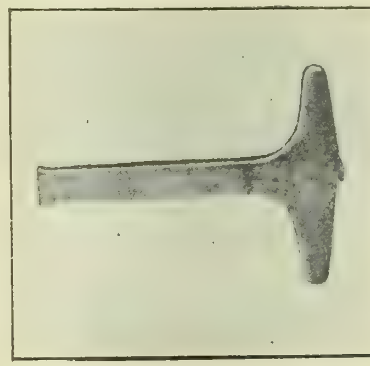


Fig. 15.—Shear along Die Line in Nickel Chrome Steel.

quickly than the top half, owing to the almost continuous contact with a comparatively large mass of cold metal in the lower die. The lower half will therefore harden off more quickly than the top half, resulting in a shearing action being set up, causing cracks through the centre of the web (Fig. 15).

It is an important fact that a design which may be easily produced in a medium carbon steel may be quite unsuitable for nickel chrome.

A further point still frequently overlooked by some designers is the danger of drastic changes of section, which is of still greater importance in parts which have to be heat-treated. The cooling and contraction of the thinner sections frequently result in

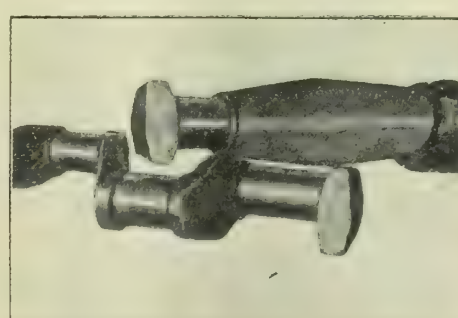


Fig. 16.—Crankshaft showing Rough Tool Marks.

cracks being formed, and it is therefore important that careful consideration be given to the treatment such pieces must undergo.

A typical instance is the case of propeller bosses, in which the great difference in section between the boss and the flange causes considerable stresses to be set up during quenching, causing cracks across the flange. The trouble may be overcome by making

a larger machining allowance, so that excess material is removed after heat treatment.

Many failures in service which are attributed to faulty drop forgings are entirely avoidable by a slight change in design or a little more time spent on machining.

Any slight marks left on aeroplane or automobile parts, which are subject to alternating stresses are liable to cause creeping cracks, which ultimately result in failure of the part. The marks are either clipping tool marks on the rough forging or rough tool marks left after machining.

In Fig. 16 is illustrated a broken crankshaft, a close examination of which showed that the material was of good quality, the analysis and physical tests being as follows:—

Analysis.		Physical Tests.	
Carbon	·289	Yield point	54·4 tons sq. in.
Silicon	·100	Ultimate strength	59·32 tons sq. in.
Sulphur	·035	Elongation	20·0 per cent.
Phosphorus	·009	Reduction of area	61·5 per cent.
Manganese	·848	Brinell hardness	258
Chromium	1·002	Impact	72·0 ft.-lb.
Vanadium	·124		

No obvious defects, such as "runs" could be seen, and the shaft had been correctly heat treated, but the clipping tool marks along the scrap line were very rough, and careful examination disclosed the fact that the crack had started at one of these tool marks, and this was confirmed by the microscope, as no run or crack could be detected at any part of the fracture.

Connecting rods often fracture for the same reason, and it is therefore of the utmost importance that all parts subjected to alternating or torsional stresses should have all such tool marks removed before being put into service.

In cases where fractures occur in parts which are machined all over, the cause is in rough tool marks,

Fig. 17.—Forging Burnt by Stamper.

and in some of the cheaper cars no attempt is made to leave a radius at the end of troughing cut, the sharp corner thus created causing failure.

An interesting case of this trouble was illustrated in the case of an aero engine propeller-shaft, which failed in service. The shaft was rough bored, and at the propeller end serrations were provided for the boss.

The crack had started from the rough boring marks, and this by itself might have been expected to cause a clean break at right angles to the axis of the shaft. The serrations, however, caused lines of weakness in a longitudinal direction, causing the crack to take a spiral course.

Many failures can be attributed to too small radii at points where there is considerable reduction in section, as, for instance, in stub axles at the point where the shank runs into the flange.

The foregoing defects can scarcely be called drop forger's troubles, but he is frequently held responsible for such failures. A thorough investigation might lead to alterations in design and in machining operations, which would effect a cure.

Defects Produced by the Drop Forger.

No doubt a very frequent cause of scrapping drop forgings is overheating and burning during the forg-

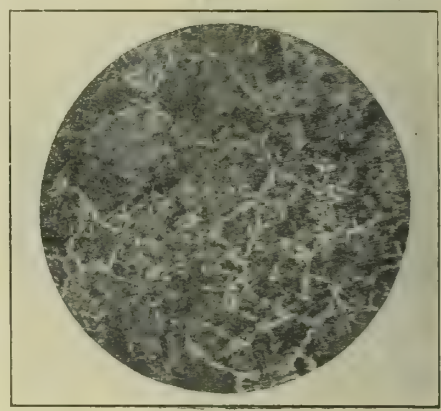


Fig. 18.—Structure of Overheated Steel.

ing process (Fig. 17), and in this connection the drop forger is in a difficult position in regard to furnaces. The totally enclosed muffle obviates burning troubles to a large extent, but is far too slow for high output, while muffles with open ports and forced draught are better in this respect, but require more careful working. Coke fires are dangerous, particularly when alloy steels are being dealt with.

Fig. 19.—Structure of Burnt Steel.

Burning, however, is not invariably the fault of the drop forger, as billets are occasionally seen showing unmistakable signs of burning on receipt from manufacturers. This is not a common occurrence, however, but it is very probable that billets are frequently overheated before reaching the stamper's works.

Although frequently used to express the same defect, there is a great difference between overheat-

ing and burning. Overheating is a condition which can be remedied by subsequent heat treatment, whereas burning renders a piece beyond recovery (Figs. 18 and 19).

If a steel be subjected to a high temperature for any length of time, the metal develops a very coarse structure and the crystals become very large, their size increasing with increase of temperature, and it will often be noticed in the case of medium carbon steels that offshoots from the ferrite crystal boundaries run into pearlite areas, rendering the steel very brittle. Such a steel, however, can be brought into its normal condition by simply heating above the critical range and allowing to cool off in air.

It is fairly obvious to anyone conversant with the process of drop forging that all steel forgings are very liable to be overheated, owing to the fact that working has to be carried out in the region of 900 deg. Cen. to 1,100 deg. Cen. It is, therefore, very much in the interests of automobile manufacturers that all carbon steel forgings should be normalised, and alloy steels be either annealed or finally heat treated before delivery. This will obviate breakages due to rough handling in transit or in the machining operations. The user of the forgings is very apt to blame the drop forger when such breakages occur, but this is another case where lack of knowledge of the working conditions of the process often leads to misunderstanding between the parties concerned.

The burning of steel is a subject which is of vital importance to the drop forger, and up to the present very little work seems to have been carried out to

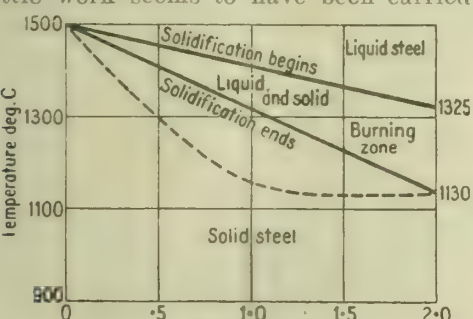


FIG. 20.—Diagram illustrating Burning Zone.

determine the exact condition under which burning can take place.

Burning, according to some authorities, commences with the evolution of carbon monoxide due to the action of oxygen on the carbon of the steel, when the crystal grains are separated, and ultimately oxidation of the iron takes place among the cavities formed. At the higher temperatures, before the "burning zone" is reached, the grains become greatly enlarged, with a resulting weakening along the crystal boundaries. Oxidation then takes place along the lines between the crystals, the carbon being removed first, the iron then becoming oxidised.

This oxidisation along the crystal boundaries occurs when the steel has been heated to temperatures of incipient fusion, and the accompanying diagram (Fig. 20) illustrates the ranges over which the steel may be burnt. This is simply a section of the iron carbon equilibrium diagram covering the percentages of carbon present in steel. It will be seen that the liquefaction and solidification of carbonless iron takes place at one temperature, viz., 1,500 deg. Cen. As the percentage of carbon increases a solidification range is introduced, during which both solid and liquid steel are present. Solidification with carbonless iron takes place at 1,500 deg. Cen., and this temperature decreases with increase of carbon down to 1,325 deg. Cen., with 2 per cent carbon. The temperature at which solidification ends is 1,500 deg. Cen., with no carbon present, decreasing to 1,125 deg. Cen. at 2 per cent carbon.

It will be noticed that the "burning zone" is enclosed by straight lines between the two extreme

FIG. 21.—Fracture of Overheated Nickel Chrome Steel.

temperatures, but later results by Gutowsky suggest that the true temperatures at which solidification ends are somewhat lower, as shown by the curved dotted lines.

If a steel has been "burnt" in the true sense of the term, no amount of heat treatment can restore it to a perfect condition in spite of the claims which are made that there are certain heat treatments which restore such a steel. It is obvious that if oxide inclusions are present due to burning, although heat treatment may possibly refine the structure to a certain extent, the oxide is still present, forming a great source of weakness, especially where the steel is subject to alternating stresses or shock. Remelting only can remove such oxide from the steel.

In the case of nickel chrome steels there is a condition brought about by extreme overheating, in which, although the steel is not actually burnt, heat treatment will not restore the structure (Fig. 21). Impact and tensile tests show a very granular fracture, and it is found that this is caused by overheating, without subsequent work being put upon the steel, and it is usually the result of the last forging heat. If the steel be well worked after this overheating, a normal structure can be obtained after the usual quenching and tempering operations.

A defect which is often mistaken for burning is often seen with certain types of nickel chrome steel containing high percentages of chromium. This defect has been noticed when the temperature at which the forgings were worked could not possibly have caused burning. After watching the forging operations for some time, it was proved that the wind, impinging on the forgings at certain points, caused a cooling which prevented a proper flow of metal there. The metal surrounding, still being in a plastic condition, came together at these points, causing cracks which had every appearance of burns. The removal of the wind pipes entirely obviated this trouble.

Blanks having a central hole often show cracks round the die line. This is due to the wad cooling

much more quickly than the forging itself, thus preventing a proper flow of metal. A run is thus produced which may extend a considerable depth into the forging.

There are many defects which hardly need explanation, as their causes are only too well known. These include runs due to laying the metal in short, cracks originating from sharp dummy tools, cracks caused by the clipping punch not being correctly shaped and digging in, and laps in drawing down, particularly in working round from round.

In some cases it is a difficult matter to distinguish between defects caused by the drop forger and those caused by defective steel, and it is only by watching the work carefully at every stage that a decision may be arrived at.

Die Blocks.

As in all other processes, a drop forger is liable to have trouble with his plant and tools, but it would be a difficult matter to find any trade which had such a troublesome item in its equipment as die blocks. It frequently happens that a new pair of die blocks are broken on the first forging, and, although the cause may be due to bad handling on the part of the stamper, provided that the blocks are sound and perfectly normalised, breakages should be of rare occurrence.

The steel which is now used (a 0·50-0·60 carbon steel) is probably must suitable for general work,

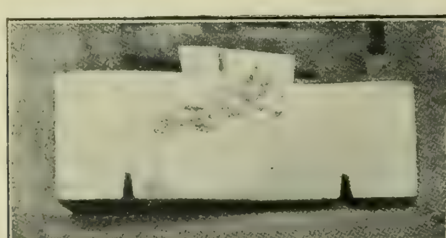


FIG. 22.—Die Block Broken through Large Slag Inclusions.

and the majority of failures can be attributed to one or more of four troubles:—

(1) Want of proper care in the selection of blooms. Many die blocks which break contain large slag inclusions (Fig. 22). These may be cut through in sinking the impression, and under these conditions the die is practically certain to fail.

(2) Insufficent work in forging the die down from the ingot bloom. It is often noticed that the structure on the outer edge of a broken die is fairly fine, while the interior is extremely coarse. No doubt there is a temptation for the maker to use a bloom which requires the minimum amount of forging, but it should be realised that many dies require an impression to be sunk for a depth of 6 in. This penetrates that part of the die which has not felt the effect of the forging work, and which probably retains the coarse ingot structure. This is naturally weak, and cracks, of course, soon develop.

(3) Dies are not properly normalised after forging. As previously remarked, forgings are very apt to be overheated, and die block forgings are no exception. An overheated structure is essentially a cause of brittleness, and, unless normalised properly, the die is not in a fit state for working (Figs. 23 and 24).

The die forger's method of normalising is, to say the least, somewhat crude, and can in no way be said to comply with the Engineering Standards Committee's definition of this term: "Normalising means heating a steel (however previously treated) to a temperature exceeding its upper critical range and allowing it to cool freely in air."

The method referred to is that of cooling off in ashes from the temperature at which forging is completed. This temperature may be considerably below

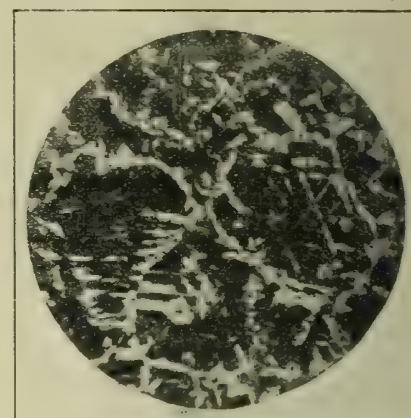


FIG. 23.—Microphoto of Section of Die Block, showing Overheated Condition.

the critical range, and in such a case there is no possibility of the overheated structure being broken down.

No doubt, even if normalising be carried out properly, the centre of a large die block will remain somewhat coarser than the outside, but it is certain that it will be in a condition far superior to that of the majority of die blocks sent out at the present time.

(4) Die blocks are sometimes forged with the fibre running parallel to the vertical axis, whereas to obtain the best results it should be at right angles to the axis. This is particularly dangerous in the

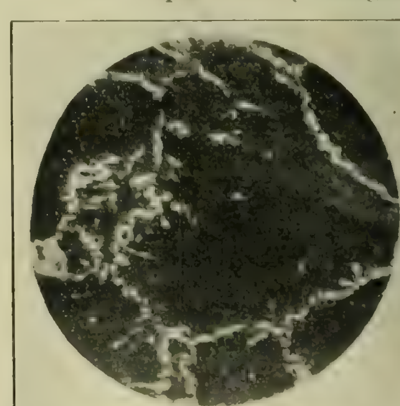


FIG. 24.—Microphoto showing Overheated Structure of Section of Die Block.

case of dies having a deep impression, as they are extremely liable to burst under the wedging effect of the steel.

In conclusion, there should be closer co-operation between designer, drop forger, and steel maker, and when the drop forger's requirements and difficulties were more fully realised by both steel manufacturers and customers, many of their troubles would disappear and output would be vastly increased.

TOOL GRINDERS.

THE Lumsden curved lip tool grinder, which is shown at Figs. 1 and 2, is a development of the principle embodied in the curved lip attachment supplied with the "Lumsden" oscillating tool grinder, and is designed with the object of producing curved lip tools with much greater facility than is possible

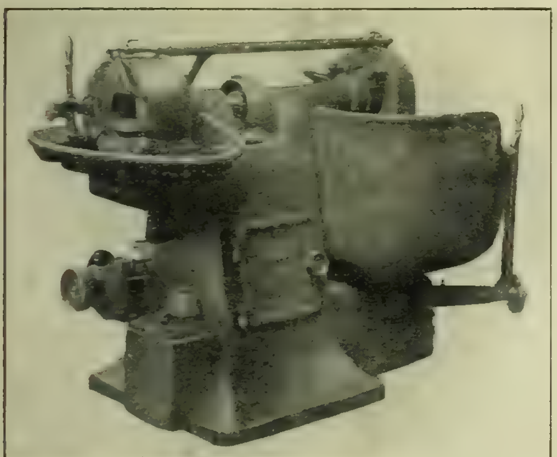


FIG. 1.—Lumsden Curved Lip Tcol Grinder, No. 71 Machine.

with an attachment. The machine is of the double-ended type, one end being arranged for grinding curved lip tools and the other a plain cup-wheel grinder.

The body of the machine, as will be seen from Figs. 1 and 2, is of taper box section, with a cup-wheel mounted and a cup-wheel back. The driving spindle, which is mounted on ball bearings with ball

FIG. 2. Lumsden Curved Lip Tool Grinder, No. 71 Machine.

thrust washers, is driven by a pulley as shown, from the ball bearing countershaft which is self-contained with the machine. A centrifugal pump, driven by belt from the countershaft, supplies an adequate flow of water to both grinding wheels. The curved lip mechanism consists of a horizontal traversing slide mounted on a column having vertical adjustment. This slide is pivoted on the column, and can be swung round and secured at any desired angle in the horizontal plane to the wheel. Mounted on the slide is a cross slide carrying a swivelling vice, the base of which is mounted at an angle of about 40 deg. to the slide. All controls are operated by hand. A large cast-iron trough protects the operator from the water and dust, the elevating and traversing controls being outside the trough.

The end of the machine carrying the 12 in. diameter cup-wheel carries a tool rest and wheel dresser, this end being used for retouching the flat faces of tools after hardening. The self-contained countershaft fast and loose pulleys are 8 in. diameter by 3$\frac{3}{4}$ in. face, the loose pulleys being mounted on ball bearings. The countershaft speed is 675 revolutions per minute, and the spindle speed 1,450 revolutions per is 20 cwts., and the floor space occupied is 6 ft. 8 in. by 3 ft. 10 in.

Method of Operating Curved Lip Mechanism.

In producing curved lip tools, the tool is secured in the vice, the vice swung round until the cutting edge of the tool is parallel with the bottom traverse slide, the traverse slide in its turn moved round to the desired angle for giving the required top rake (the further the traverse slide is moved round from its position parallel with the face of the wheel the less the top rake of the tool), and the whole raised by the elevating control until the tool touches the periphery of the grinding wheel. The tool is then reciprocated across the periphery of the wheel, and at the same time gradually fed up by the elevating control until the desired depth of cutting clearance is attained.

The Basingstoke works of Messrs. John I. Thornycroft & Co. Ltd. were recently visited by the Crown Prince Purachatra of Siam. The Prince is the General of Engineering for Siam, and has the control of all roads and railway transport in that country, and he showed great interest in the Thorncroft works. On the following day he visited the Thornycroft shipbuilding works at Southampton, when the Crown Princess Prahavadeshidi performed the launching ceremony of the "Ville de St. Amarin," a 2,000-ton cargo vessel building for French owners.

HOLDSWORTH & SONS LTD.—We have received this firm's catalogue of 34 pages, which is profusely illustrated with photographs and drawings of Lancashire, Cornish, and vertical boilers. In order to assist their clients, Messrs. Holdsworth are prepared: (*a*) To carry out evaporation and efficiency tests of their steam plant; make a thorough inspection of the external brickwork and furnace conditions; and submit a report stating what alterations, if any, are necessary. (*b*) To inspect the general conditions of their boiler-house plant periodically (four times per year); test the flue gases, and advise the boiler firemen how to secure the best results. There is much useful information in the catalogue for steam users, such as a table giving the variable ratio between grate area and outlet at the rear end of fire-boxes; variable air velocities through furnaces, etc.

AUTOMATIC AND ELECTRIC FURNACES LTD.—This company has issued a new illustrated catalogue of their "Flat" electric furnace. They have just placed on the market a new design of furnace, embodying all the principles of the Wild-Barfield furnaces, *i.e.*, detection of critical temperature, etc., with the added refinement of the excess temperature cut-out, which makes electric furnaces safe in the hands of inexperienced workers, because it prevents the overheating and consequent burning out of heating windings in electric furnaces. This consists of a small loop of wire which enters the furnace for a short distance, the heating current passing through this loop. So long as the loop is intact the current will heat the furnace. Should, however, the temperature of the furnace, due to neglect, become excessive and so endanger the heating winding, the wire loop fuses and cuts off the heating current and at the same time a red pilot lamp lights up and a new loop can be immediately inserted. Unless otherwise specified, wire loops having a fusing point of 960 deg. Cen. are supplied.

AN EFFICIENT FORCED DRAUGHT FURNACE.

A Power User's Problem.

It is becoming more imperative all the time for the power user and the engineer to get the maximum of efficiency from boiler plants. Fuel costs are so high that before installing a plant the claims of the various furnaces on the market should be examined closely, and with old plant the possibility of substituting a new and economical furnace at small expense cannot be ignored. There is a large number of mills and factories with Lancashire or vertical boilers in which the cost of fuel, even to get a comparatively low efficiency, is ruinous. They have been deterred from adopting one of the older systems of forced or induced draught because of the direct cost, the dislocation and problematical maintenance expenses. Mechanical draught possesses so many advantages over natural draught, however, that it is always advisable to substitute it. It is more adaptable, as blowers may be applied in almost all circumstances and quite independently of location or climatic conditions. The essentials for a forced draught system are flexibility and control, which qualities are lacking with natural draught, because with natural draught its intensity depends on the intensity of the fire, and is least when the fire is low; but with forced or reduced draught the condition of the fire is immaterial, and thus banked fires may be started very quickly. Direct economy is effected because the lowest grade of fuel can be used owing to the intensity of the draught, and the amount of steam generated by the boiler is also greatly increased.

The Turbine Furnace.

There are several systems of artificial draught in use nowadays either on the forced or induced principle. In the induced draught system a partial vacuum is created in the chimney with fans, in a forced draught system the air is forced into the ash-

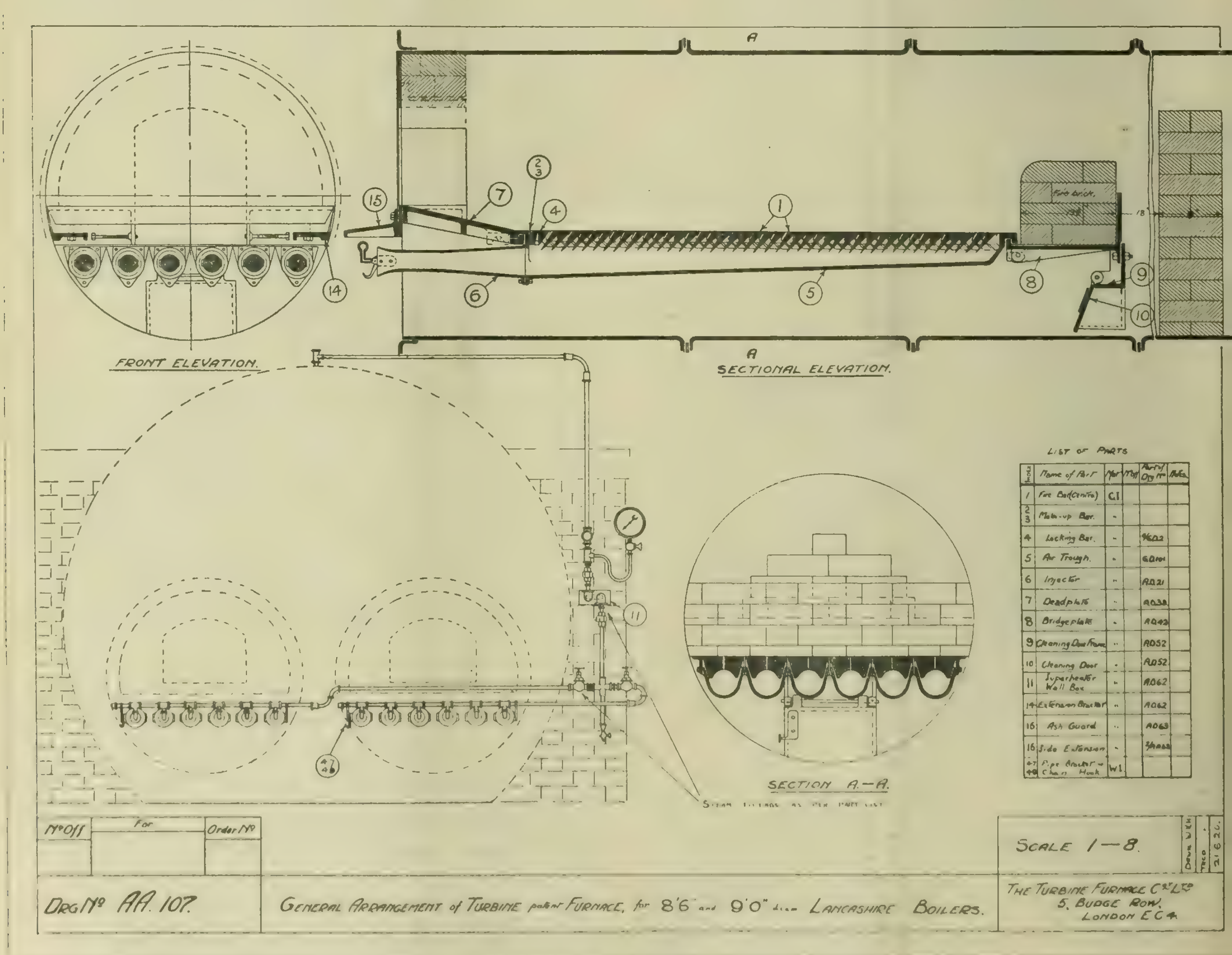


FIG. 1.

pit either by means of a steam jet or a fan blower. A furnace which has come to the front within the last few years, and which has many features that render it peculiarly suitable for mill and factory boiler plants is the turbine furnace which is made by the Turbine Furnace Co, 5, Budge Row, London E.C.4. It is a forced draught furnace with steam jet blowers, and its name is derived from the unique design, which is yet exceedingly simple. In principle it is based on the impulse turbine, and in design and construction it is strikingly similar to the impulse turbine. It is equally suitable for Lancashire or other horizontal boilers and for vertical boilers. Large numbers of Cochran boilers are now fitted with these furnaces. It is ingenious in its simplicity, because great care and considerable calculations have been undertaken in order to assure that the air pressure on every square inch of the grate area shall be equal. And this is a very great advantage the Turbine furnace has over the ordinary natural draught furnace. Unequal combustion in a furnace is very destructive of boilers. It is not possible to prevent holes in a fire through which there is a comparatively excessive draught. The ideal furnace is one in which the combination of air and fuel is equal over all the grate area. That claim, the very reasonable claim, we think, is made for the turbine furnace.

Constructional Details.

The furnace proper consists of a number of D-shaped units, which may be termed air troughs, and are illustrated at 5 (Fig. 1). It will be observed that the trough is of diminishing section from front to back of the boiler in order that the pressure may be equal along its entire length. These troughs are placed longitudinally in the furnace flue, and they are made of cast iron. They bed nicely in position between the bridge plate 8 and the dead plate 7, because the resting edges are designed for three point contact which prevents any inclination to rock. The troughs are 5in. wide across the top, while at the bottom the radius is 2 in. The sizes of these troughs are standard, and the number depends, of course, on the size of the boiler. The disposition of the firebars is most easily understood by looking at Fig. 2, which shows the back and the front of two firebars. The firebars rest on the trough edges, and when they are locked into each other there is a space ⅛ in. wide at the top edges. Each firebar has a rib and a slot, the rib of one fitting into the slot of the following one. Placing the firebars into the trough is an easy matter, and no movement can take place. The end firebar 4, Fig. 1, cannot be made standard, as it is a locking bar, or what may be termed a distance piece. When all the firebars have been slid into position in the trough the locking bar, or distance piece, is the last piece to be inserted. The space between the firebar castings is preserved by the feather and the raised step which is plainly seen in Fig. 2. The bars project forward, of course, and as the slot between each two bars is tapered owing to the rear face being at 45 deg. to the top surface of the grate, while the forward surface is at an angle of 60 deg. to the top surface, the resistance to the air pressure is reduced to a minimum. This resistance is further reduced by the circular form of the bottom of the ribs, which is seen at A A Fig. 1, as the air rushes through the slots it diminishes in quantity in the trough, and the result of this is equalised by the diminishing section of the trough, which ensures constant velocity of the air.

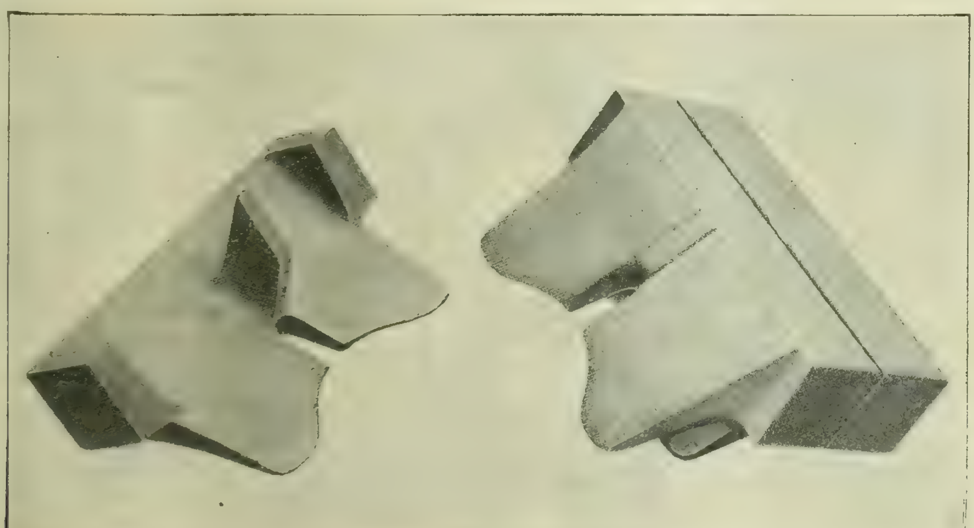


Fig. 2.

The troughs are not complete until the injectors 6, Fig. 1, are bolted to them, each injector having a steam jet. The injectors are so designed that there is no resistance to the air. The brass nozzles have a coefficient of contraction of 0·67. Steam jet systems are frequently condemned by engineers because of their wastefulness in steam, so it is worth pointing out that in this furnace very small jets—only $\frac{1}{16}$ in.—are used, which obviate waste.

General Construction.

The view shown at Fig. 1 illustrates very clearly the construction of the furnace. The dead plate is a casting which fits within the curved sides of the furnace walls. While being about 1½ in. below the centre line of the furnace at the front it slopes downwards another 3 in. to 5 in., and this gives a valuable

increase of room for combustion. The bridge piece 8, Fig. 1, is also of cast iron. Both the dead plate and the bridge plate have what may be termed flanges cast on them, over which the flanges on the troughs fit. The dead plate is held in position by means of the same bolts that hold the ash guard in position, assisted by extension pieces which are indicated in dotted outline at A, Fig. 1. The object of the ash guard is to protect the steam jets from the ashes raked over the dead plate. The bridge plate is fixed with bolts to the cleaning door frame 9. On the top of the bridge there is the usual firebrick construction, and a combustion chamber is provided by a second firebrick bridge being built about 18 in. behind this, so that the flames are evenly distributed round the furnace. Air is admitted to this combustion chamber through the cleaning door under the front bridge.

There is a distance between the outer troughs and the furnace walls, and these are filled with distance or extension pieces, which are clearly shown at 14, Fig. 1. Apart from the necessity for these distance pieces because of the design, it is well that the intense flame created by the draught should not be in too close contact with the furnace shell.

Vertical Boilers and Forced Draught.

Very notable success has been obtained by the furnace installed in vertical boilers, and notably the Cochran boiler. This is the more remarkable as the vertical boiler has never been thought suitable for any kind of artificial draught system. The principle and many of the constructional details are the same for the vertical boiler, but because of the shape of the firebox it is necessary to have four cast-iron segments to fill the space between the air troughs and the wall. The troughs rest on the front and back segments. Fig. 3 shows the furnace fitted to a Babcock & Wilcox boiler.

In operation there is no complicated mechanism about the furnace. The ordinary fireman is quite able, unassisted, to do all that is ever necessary to

RATHMINES U.D.C. ELECTRICITY WORKS. FUEL COSTS.

EXTRACTS FROM LOG FOR 10 DAYS BEFORE AND AFTER INSTALLATION OF THE TURBINE FURNACE.

Two Lancashire Boilers, 30′ × 8′, Fitted with Mechanical Stokers and Dust Destructor.

Date.	Total Units Generated.	Total Coal Used.		Price of Coal per ton.	Cost of Coal.	Lbs. Coal per Unit Generated.	Cost of Coal (in pence) per Unit Generated.
		Tons	Cwts.		£ s. d.		
July 17	1931	4	1	26/-	5 5 0	1·6	·640
„ 18	1417	3	13	..	4 15 0	5·7	·795
„ 19	1886	3	7	..	4 7 0	3 9	·543
„ 20	2055	3	7	..	4 7 0	3·5	·488
„ 21	2146	3	14	..	4 16 0	3·8	·529
„ 22	2098	3	16	..	4 19 0	4·05	·564
„ 23	2134	3	14	..	4 16 0	3·8	·529
„ 24	1801	4	0	..	5 4 0	4·8	·678
„ 25	1378	3	13	..	4 15 0	5·9	·821
„ 26	2024	4	4	..	5 9 0	4·6	·640
Totals ..	18,870	37	9	..	£48 13 0	.	..
Average ..	1887	3	15	26/-	£4 17 4	4·44	·620

One Lancashiree Boiler, 30′ × 8′, Fitted with Turbine Patent Furnace and Dust Destructor.

Date.	Total Units Generated.	Fuel—Coal.		Used Coke.		Price of Fuel per Ton.		Cost of Fuel.	Lbs. Fuel per Unit Generated.	Cost of fuel in pence per Unit Generated.
		Ton.	Cwt.	Ton.	Cwt.	Coal.	Coke.	£ s. d.		
July 28	1963	Coal	18	2	14	26/-	8/6	2 6 4	4·1	·284
„ 29	2160	..	17	2	9	26/	8/6	2 2 10	3·4	·238
„ 30	2290	Slack 1	6	2	0	21/-	8/6	2 4 2	3·2	·232
„ 31	2260	„ 2	4	1	4	21/-	8/6	2 16 4	3·3	·299
Aug. 1	1506	„ 1	15	1	10	21ö-	8/6	2 9 6	4·8	·394
„ 3	1686	.. 1	0	1	12	21/-	8/6	1 14 7	3·4	·246
„ 4	2434	Coal 1	0	3	18	26/-	8/6	2 19 2	4·5	·292
„ 5	2100	.. 1	0	2	18	26/-	8/6	2 10 8	4·1	·289
„ 6	2285	..	..	5	0	..	8/6	2 2 6	4·9	·223
„ 7	2171	..	14	4	10	26/-	8/6	2 16 8	5·3	·312
Totals ..	20,855	10	14	27	15	..	..	£24 2 6	..	..
		38 tons 9 cwts.								
Average	2085	3—17				12/5	..	£2 8 3	4·12	·280

Net Calorific Value = 62 - 28 = $\frac{34}{62}$ = 55 per cent.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 102 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 0 12	0 18 0 20	1 7 1 8	1 16 1 20	2 5 2 4	2 14 2 16	3 3 3 0	3 12 3 12	4 1 3 24	0
1	0 3 18	10 0 2	0 19 0 14	1 8 0 26	1 17 1 10	2 6 1 22	2 15 2 6	3 4 2 18	3 13 3 2	4 2 3 14	1
2	1 3 8	10 3 20	1 0 0 4	1 9 0 16	1 18 1 0	2 7 1 12	2 16 1 24	3 5 2 8	3 14 2 20	4 3 3 4	2
3	2 2 26	11 3 10	1 0 3 22	1 10 0 6	1 19 0 18	2 8 1 2	2 17 1 14	3 6 1 26	3 15 2 10	4 4 2 22	3
4	3 2 16	12 3 0	1 1 3 12	1 10 3 24	2 0 0 8	2 9 0 20	2 18 1 4	3 7 1 16	3 16 2 0	4 5 2 12	4
5	4 2 6	13 2 18	1 2 3 2	1 11 3 14	2 0 3 26	2 10 0 10	2 19 0 22	3 8 1 6	3 17 1 18	4 6 2 2	5
6	5 1 24	14 2 8	1 3 2 20	1 12 3 4	2 1 3 16	2 11 0 0	3 0 0 12	3 9 0 24	3 18 1 8	4 7 1 20	6
7	6 1 14	15 1 26	1 4 2 10	1 13 2 22	2 2 3 6	2 11 3 18	3 1 0 2	3 10 0 14	3 19 0 26	4 8 1 10	7
8	7 1 4	16 1 16	1 5 2 0	1 14 2 12	2 3 2 24	2 12 3 8	3 1 3 20	3 11 0 4	4 0 0 16	4 9 1 0	8
9	8 0 22	17 1 6	1 6 1 18	1 15 2 2	2 4 2 14	2 13 2 26	3 2 3 10	3 11 3 22	4 1 0 6	4 10 0 18	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·5	17·0	25·5	1 6	1 14·5	1 23	2 3·5	2 12	2 20·5	3 1	3 9·5	3 18	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 102 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 11 0 8	9 2 0 16	13 13 0 24	18 4 1 4	22 15 1 12	27 6 1 20	31 17 2 0	36 8 2 8	40 19 2 16	0
10	0 9 0 12	5 0 0 20	9 11 1 0	4 2 1 8	18 13 1 16	23 4 1 24	27 15 2 4	32 6 2 12	36 17 2 20	41 8 3 0	10
20	0 18 0 24	5 9 1 4	10 0 1 12	11 11 1 20	19 2 2 0	23 13 2 8	28 4 2 16	32 15 2 24	37 6 3 4	41 17 3 12	20
30	1 7 1 8	5 18 1 16	10 9 1 24	15 0 2 4	19 11 2 12	24 2 2 20	28 13 3 0	33 4 3 8	37 15 3 16	42 6 3 24	30
40	1 16 1 20	6 7 2 0	10 18 2 8	15 9 2 16	20 0 2 24	24 11 3 4	29 2 3 12	33 13 3 20	38 5 0 0	42 16 0 8	40
50	2 5 2 4	6 16 2 12	11 7 2 20	15 18 3 0	20 9 3 8	25 0 3 16	29 11 3 24	34 3 0 4	38 14 0 12	43 5 0 20	50
60	2 14 2 16	7 5 2 24	11 16 3 4	16 7 3 12	20 18 3 20	25 10 0 0	30 1 0 8	34 12 0 16	39 3 0 24	43 14 1 4	60
70	3 3 3 0	7 14 3 8	12 5 3 16	16 16 3 24	21 8 0 4	25 19 0 12	30 10 0 20	35 1 1 0	39 12 1 8	44 3 1 16	70
80	3 12 3 12	8 3 3 20	12 15 0 0	17 6 0 8	21 17 0 16	26 8 0 24	30 19 1 4	35 10 1 12	40 1 1 20	44 12 2 0	80
90	4 1 3 24	8 13 0 4	13 4 0 12	17 15 0 20	22 6 1 0	26 17 1 8	31 8 1 16	35 19 1 21	40 10 2 4	45 1 2 12	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs	t. c. q lbs	t. c. q. lbs	Weight.
	45 10 2 24	91 1 1 20	136 12 0 16	182 2 3 12	227 13 2 8	273 4 1 4	318 15 0 0	364 5 2 29	409 16 1 20	455 7 0 16	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 103 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	Ft.
0	..	9 0 22	0 18 1 16	1 7 2 10	1 16 3 4	2 5 3 26	2 15 0 20	3 4 1 14	3 13 2 8	4 2 3 2	0
1	0 3 19	10 0 13	0 19 1 7	1 8 2 1	1 17 2 23	2 6 3 17	2 16 0 11	3 5 1 5	3 14 1 27	4 3 2 21	1
2	1 3 10	11 0 4	1 0 0 26	1 9 1 20	1 18 2 14	2 7 3 8	2 16 3 2	3 6 0 24	3 15 1 18	4 4 2 12	2
3	2 3 1	11 3 23	1 1 0 17	1 10 1 11	1 19 2 5	2 8 2 27	2 17 3 21	3 7 0 15	3 16 1 9	4 5 2 3	3
4	3 2 20	12 3 14	1 2 0 8	1 11 1 2	2 0 1 24	2 9 2 18	2 18 3 12	3 8 0 6	3 17 1 0	4 6 1 22	4
5	4 2 11	13 3 5	1 2 3 27	1 12 0 21	2 1 1 15	2 10 2 9	2 19 3 3	3 8 3 25	3 18 0 19	4 7 1 13	5
6	5 2 2	14 2 24	1 3 3 18	1 13 0 12	2 2 1 6	2 11 2 0	3 0 2 22	3 9 3 16	3 19 0 10	4 8 1 4	6
7	6 1 21	15 2 15	1 4 3 9	1 14 0 3	2 3 0 25	2 12 1 19	3 1 2 13	3 10 3 7	4 0 0 1	4 9 0 23	7
8	7 1 12	16 2 6	1 5 3 0	1 14 3 22	2 4 0 16	2 13 1 10	3 2 2 4	3 11 2 26	4 0 3 20	4 10 0 14	8
9	8 1 3	17 1 25	1 6 2 19	1 15 3 13	2 5 0 7	2 14 1 1	3 3 1 23	3 12 2 17	4 1 3 11	4 11 0 5	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·59	17·18	25·77	1 6·36	1 14·95	1 23·54	2 4·13	2 12·72	2 21·31	3 1·90	3 10·94	3 19	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 103 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	4 11 3 24	9 3 3 20	13 15 3 16	18 7 3 12	22 19 3 8	27 11 3 4	32 3 3 0	36 15 2 24	41 7 2 20	0
10	0 9 0 22	5 1 0 18	9 13 0 14	14 5 0 10	18 17 0 6	23 9 0 2	28 0 3 26	32 12 3 22	37 4 3 18	41 16 3 14	10
20	0 18 1 16	5 10 1 12	10 2 1 8	14 14 1 4	19 6 1 0	23 18 0 24	28 10 0 20	33 2 0 16	37 14 0 12	42 6 0 8	20
30	1 7 2 10	5 19 2 6	10 11 2 2	15 3 1 26	19 15 1 22	24 7 1 18	28 19 1 14	33 11 1 10	38 3 1 6	42 15 1 2	30
40	1 16 3 4	6 8 3 0	11 0 2 24	15 12 2 20	20 4 2 16	24 16 2 12	29 8 2 8	34 0 2 4	38 12 2 0	43 4 1 24	40
50	2 5 3 26	6 17 3 22	11 9 3 18	16 1 3 14	20 13 3 10	25 5 3 6	29 17 3 2	34 9 2 26	39 1 2 22	43 13 2 18	50
60	2 15 0 20	7 7 0 16	11 19 0 12	16 11 0 8	21 3 0 4	25 15 0 0	30 6 3 24	34 18 3 20	39 10 3 16	44 2 3 12	60
70	3 4 1 14	7 16 1 10	12 8 1 6	17 0 1 2	21 12 0 26	26 4 0 22	30 16 0 18	35 8 0 14	40 0 0 10	44 12 0 6	70
80	3 13 2 8	8 5 2 4	12 17 2 0	17 9 1 24	22 1 1 20	26 13 1 16	31 5 1 12	35 17 1 8	40 9 1 4	45 1 1 0	80
90	4 2 3 2	8 14 2 26	13 6 2 22	17 18 2 18	22 10 2 14	27 2 2 10	31 14 2 6	36 6 2 2	40 18 1 26	45 10 1 22	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	45 19 2 16	91 19 1 4	137 18 3 20	183 18 2 8	229 18 0 29	275 17 3 12	321 17 2 0	367 17 0 16	413 16 3 4	459 16 1 20	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

keep the furnace in order. Very little dust or ash falls through the slots into the troughs, and that little is easily removed with a cleaning rod or scoop. The cleaning can be done in a few minutes and only requires the fireman's attention two or three times in the working day. The ash and clinker are removed by raking them over the dead plate. There is no better test of a forced draught system than the quality of the fuel that can be used. Whether with a Lancashire, a Cornish, or a vertical boiler the very poorest fuel is serviceable with the furnace we are considering. The "washery duff," of which there are great heaps at all our collieries, and which is usually considered as waste, makes quite good fuel, and coke dross is equally satisfactory. After stoking the fire it is a matter of seconds almost till there is a beautifully intense and uniform flame in the furnace. Superheated steam has been found more satisfactory than saturated steam. It is claimed that it increases the efficiency of the jets, because for equal weights the volume delivered is greater if the steam is superheated. In tests carried out to ascertain if the pressure of air in the troughs was uniform throughout the entire length it was found that when the pressure of steam

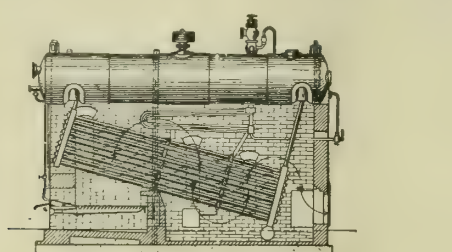


Fig. 3.

delivered to the jets was 30 lb. the pressure in the troughs was 0·3in. of water. A steam pressure of 40 lb. gave an air pressure of 0·4 in. and one of 50 lb. gave an air pressure of 0·5 in. For the furnace consisting, as it does, of a number of units, each receiving its own air supply, small jets are efficient for creating the draught, and thus economy is effected. The ease with which old boilers can be fitted with these furnaces scarcely needs to be pointed out.

Durability.

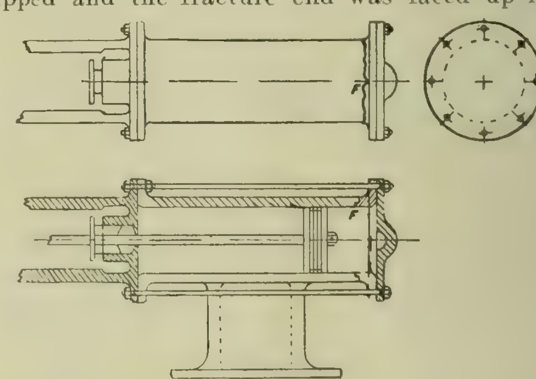
In furnaces which the writer inspected and which had been in constant use for over four years, there was no visible sign of wear and renewals had not been necessary. The firebars were as good as when made, and to all appearance would last for an interminable time. In breweries, in laundries and in Lancashire cotton mills. Turbine furnaces have been working for several years and under varying conditions, and for the different type of boilers they appear to have given very great satisfaction. Several exhaustive tests have been carried out to prove the relative efficiency of these furnaces burning results which were obtained in the Urban District Council's Electricity Works at Rathmines two or three years ago. The price of coal has risen considerably in the interval, but as a record of comparative costs the table is still valuable. At the station the full load is 330 kw., and to supply steam two 30 ft. by 8 ft. Lancashire boilers, fitted with mechanical stokers, were in use. The steam supply was augmented by that derived from a dust destructor. Before fitting the type of furnace described above, a 10 days' test was carried out on the plant. The coal used cost 26s. per ton, and on the average 3 tons 15 cwt. were consumed per day. The average number of units generated for this consumption was 1,887, so that the coal used amounted to 4·44 lb. per unit generated, or put otherwise, the cost of coal per unit generated was 0·62 pence.

One of the boilers was then laid off and the other fitted with a "Turbine" furnace. The performance of this boiler with the destructor was then tested over ten days. It was found that the capacity was now quite sufficient, without the second boiler, to take the full load. It still remained sufficient even when the dust destructor was shut down. On one occasion, with the destructor shut down, the single boiler took the full load with nothing but coke breeze fired to the furnace. Over the ten days a total of 20,855 units were generated. The total consumption of fuel was 38 tons 9 cwt. made up of 4 tons 9 cwt. of coal, 6 tons 5 cwt. of slack and 27 tons 15 cwt. of coke breeze. Thus not only was it found possible to do without the second boiler, but the cost for fuel was reduced by 55 per cent.

REPAIR TO A STEAM ENGINE CYLINDER.

By H. Maplethorpe.

The sketch shows a broken steam engine cylinder, and the method which was used to effect a temporary repair. The accident was caused by the piston nut stripping its thread, with the result that the back cover was knocked off, taking with it the cylinder flange as shown, the fracture taking place right through the steam port passage. To replace the cylinder would take at least three to four weeks, and as this engine was most urgently wanted it was decided to try the following. The cylinder was stripped and the fracture end was faced up in the



lathe, a small recess being turned to form a forcet and spigot joint as shown; a pattern for a new flange, with a part of the steam passage cast in it, was made, a casting made and turned up in the latter, thus completing the cylinder. A gasket was used to make the joint, and eight ⅞-in. long-bolts were made as shown; in drilling the cover care was taken that the holes registered with those in the engine bed, and the bolts were passed right through both cylinder flanges. Four of the bolts were screwed about 5 in. down at one end, and an additional nut was used to make the joint more secure; eight bolts were used in all.—*The Power User.*

Discovery of Iron and Coal in the Congo. At a recent Cabinet meeting at Brussels, M. Frank, Minister of the Colonies, informed his colleagues of the discovery of seams of coal and iron in the Congo.—Reuter.

INCREASING USE OF OIL.

The annual report of Lloyd's Register of Shipping, covering the 12 months ended June 30th last, states that the society's operations during the first complete year since the cessation of war have been of a very wide and far-reaching description. During the 12 months ended 30th June, 1920, Lloyd's Register has classed over 4,250,000 tons of shipping (following on a total of 3,800,000 tons classed in the previous 12 months); moreover, there was at the end of June last 4,930,340 tons of merchant shipping being constructed under the survey of the society's surveyors with a view to classification.

The countries in which the great bulk of the new tonnage has been built are the United Kingdom, the United States of America and Japan. Other countries in which there has been considerable shipbuilding activity during the year, and in which there is at present a large volume of tonnage being built under the inspection of the society's surveyors, are Holland, Canada, Italy (including the Trieste district), Sweden, Spain and Denmark. It may be remarked that the great amount of reconditioning work undertaken by shipbuilders after the war, and the conversion of a very large number of vessels to burn oil fuel instead of coal, have undoubtedly had the effect of limiting the output of new tonnage.

VESSELS CLASSED IN LLOYD'S REGISTER BOOK.

The number of vessels classed in Lloyd's Register Book at the close of the year ended 20th June, 1920, is 9,587 with a total tonnage of more than 25 millions gross, the details being as follows :—

Material of Construction and Description.	British.		Other Countries.		Total.	
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
Iron and Steel—						
Steam	5,173	11,725,781	3,735	12 389,475	8,908	24,115,256
Sail	105	108,150	280	455,082	385	563,232
Wood and Composite—						
Steam and Sail	143	52,000	151	288,431	294	340,431
Total......	5,421	11,885,931	4.166	13 132,988	9,587	25,018,919

Note.—Motor vessels and Sailing vessels fitted with auxiliary power are included in the figures shown for steamers.

Over 96 per cent of the total tonnage consists of steel or iron steamers.

During the 12 months ended June, 1920, plans of 1,299 vessels of 4,422,640 tons were passed by the society for construction to the classification of Lloyd's Register.

NEW TONNAGE CLASSED.

The committee assigned classes to 1,319 vessels of 4,253,523 tons gross during the year, of which 594 vessels of 1,391,808 tons were built in the United Kingdom, 480 vessels of 1,930,705 tons in the United States of America and 105 vessels of 571,129 tons in Japan. Of the total, 2,009,495 tons were built for the United States (1,735,318 tons being for the United States Shipping Board), while the tonnage built for the United Kingdom was 1,234,911, and for Japan 44,957.

Particulars of the new tonnage classed by the society during the last six years (that is to say, since the beginning of the war) are given below :—

Year.	Steam. Tons.	Sail. Tons	Total. Tons
1914-15	1,289.827	5,796	1.295.623
1915-16	789 688	521	790.209
1916-17	1,371.915	4.210	1,376,125
1917-18	2,552 607	16.517	2.569.124
1918-19	3.760 806	40.415	3.801.221
1919-20	4,186.882	66,641	4,253,523

The vessels of great size which were lost during the war have not yet been replaced, the more urgent demand being for the replacement of general cargo vessels. Included in the tonnage classed during the year were 121 vessels, of 740,430 tons, built upon the Isherwood system of longitudinal framing, of which 43 of 253,975 tons were oil tankers. The total number of vessels classed during the year which were intended for carrying oil in bulk was 55 of 275,714 tons.

STEAMERS BURNING OIL FUEL.

The new ships classed during the year which were fitted for burning oil fuel numbered 426 vessels of 1,995,788 tons gross, as against 211 vessels of 1,193,650 tons classed during the previous 12 months. A very large number of steamers which had previously burned coal have also come under the survey of the society's surveyors both in the United Kingdom and abroad, with a view to being converted to burn oil fuel.

In this connection it appears that, of the world's total tonnage of 100 tons and upwards recorded in the current edition of Lloyd's Register Book, the following approximate division as regards fuel may be made :—

Vessels representing about
- 76 per cent use coal as fuel.
- 16·3 per cent are fitted to use oil as fuel for boilers.
- 1·7 per cent use oil in internal-combustion engines.
- 6 per cent have sail power only.

Similar particulars compiled from Lloyd's Register Book for the previous year show that then, of the world's total tonnage of vessels of 100 tons and upwards, vessels representing about
- 82 per cent used coal as fuel.
- 10·5 per cent were fitted to use oil as fuel for boilers.
- 1·5 per cent used oil in internal-combustion engines.
- 6 per cent had sail power only.

VESSELS WITH OIL ENGINES.

Since the armistice a great development has taken place in the use of oil engines. During the year under review classes have been assigned to 28 new vessels of 79,805 tons, fitted with such engines as their main propelling power, 20 of these vessels having a collective tonnage of 76,993 tons. There are at present in course of construction under the society's survey upwards of 150 sets of Diesel engines, and about the same number of sets of oil engines of other than the Diesel type, approximately half of which are building in the United Kingdom. In addition, oil engines are being used in large vessels as emergency sets. The largest Diesel engines now being constructed under the society's survey are those for the Glenogle, a twin-screw vessel of 9,150 tons, having 16 cylinders, $29^{1}/_{10}$ in. in diameter, and stroke $45\frac{3}{16}$ in. The largest oil-engined vessel completed during the year was the Afrika of 8,597 tons. This vessel was fitted with Diesel engines having 12 cylinders of $29^{1}/_{10}$ in., $45\frac{3}{16}$ in. stroke. It may be noted that an increasing number of firms are now manufacturing oil engines, and that some of the engines at present being made are intended for vessels owned by large firms who previously have exclusively used steam engines in their vessels.

There have of late been considerable modifications of the design of oil engines, both of the Diesel and of other types. Most of the Diesel engines are of the four-stroke cycle, with oil fuel injected by blast of high-pressure air but modifications of the plan adopted in submarine engines for the injection of fuel by pressure alone have been sucessfully adopted. This considerably lessens the air compression plant required, as compressed air is only then required for starting and manœuvring, and some economy in power is thus effected. It is worthy of note that in one type of oil engine other than Diesel the manufacturers have developed in another direction by changing from a pressure system of fuel injection to one combining oil pressure with an added high-pressure air blast for more effectively spraying the oil.

Two types of opposed piston engines are being made. In these engines there are no cylinder covers.

The changes which are being made in oil engines other than Diesel are considerable. In the different types of engines usually made the maximum cylinder pressures range from 200 lb. to 350 lb. per square inch. At present other types are being made in which pressures of 390 lb., 450 lb., 485 lb. and 550 lb. per square inch are to be employed.

GEARED STEAM TURBINES.

The success of geared steam turbines may be measured to some extent by the fact that of the total number of vessels classed during the past year no less than 245 of 1,286,046 tons were provided with this means of propulsion.

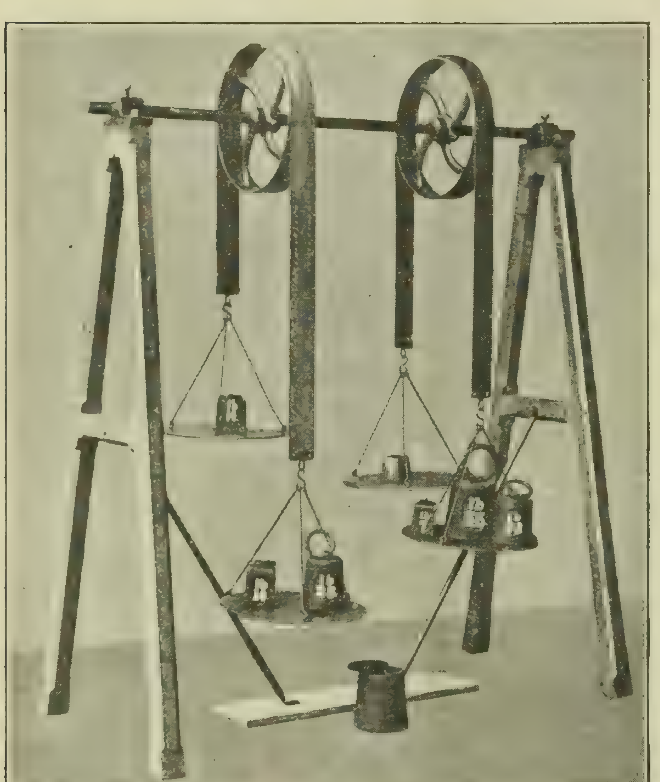
To Reduce Road Accidents.—In order to reduce the number of road accidents, the Commercial Motor Users' Association has issued a revised edition of its traffic rules and recommendations. They have been approved by the Commissioner of the Metropolitan Police, and a copy will be forwarded free on application to Mr. F. G. Bristow, 50, Pall Mall, London, S.W.1.

DEMONSTRATING THE COEFFICIENT OF A BELT.

By F. R. Parsons.

In a recent issue of the *Industrial Engineer* describing the exhibits at the Machine Tool Exhibition, the reader's attention was directed to the belt dressing known as "Cling-surface," which is marketed in this country by Thomas & Bishop Ltd., of 37, Tabernacle Street, London, E.C.2.

In this connection it might add considerably to the interest centred around this unique preparation to describe the very instructive piece of apparatus employed by this firm, and shown at their stand during the exhibition referred to, for demonstrating the advantages derivable from a systematic treatment of belts in order to maintain them in a soft and supple



condition; in other words, of increasing the coefficient of a belt.

First of all, it will be as well if we get a clear understanding of the terms "tension" and "grip," also to appreciate their dissimilarity of meaning. The tension of a belt means that force or pull which it possesses when stretched over a pulley. When a belt is running, this tension is not a fixed quantity spread equally all over the belt, it being usual to express the tension of a belt in terms relating to each side of it; that is, its driving side and its slack side. Thus, the effective pulling power of a belt is the amount of tension on the tight or driving side, less the tension on the slack side.

Now, the term "grip" means that quality which a belt possesses in clinging to the pulley face, and tending to rotate the pulley against resistance. This is usually described as the coefficient of friction of a belt, a term generally used when calculating power values. Thus, the apparatus about to be described and illustrated herewith, demonstrates the actual driving value of a belt.

The Apparatus Described.

The apparatus consists of a pair of A frames supporting a length of shafting. Keyed to this are a pair of ordinary straight-faced pulleys, about 18 in. diameter, neither these or the shafting being free to rotate. Over the two pulleys are suspended lengths of 3 in. belting, at either ends of which are attached hooks and eyes carrying scale pans. That length of belting hanging over the left-hand pulley is a dry and hard, untreated piece; that shown over the right-hand pulley has been treated with "Cling-surface."

Now, assuming any equal weights to be put in the two pans, as represented by the pair of 14 lb. weights in the left-hand illustration, grip value will be recorded when one scale pan is loaded sufficiently as to cause the belt to slip over the pulley, in this particular case the additional weight being only 28 lb. Thus, the belt was capable of exerting a pull of only 28 lb. before the slip began to occur.

In the matter of the belt treated with "Cling-surface" we see that the equalising weights are only 7 lb. each, while the weight added is 84 lb.—a total of 56 lb. more than that of the previous example—before slip occurred. In other words, the grip of the treated belt is 200 per cent greater than that of the untreated one, hence it is not difficult to see that such a belt will transmit an equivalent increase of power, the driving tension being correspondingly less.

Let us now see how this works out theoretically. If the excess weight be divided by the total weight upon the belt at the point of slipping, we shall have as the quotient the value of the coefficient of friction, or grip. Taking the first example, that is, of the dry and hard belt, the equalising weights are 14 lb. each, and the weight added 28 lb., then the coefficient of friction will be:—

$$\frac{28}{28 + 14 + 14} = \frac{28}{56} = 0{\cdot}5$$

Taking the second example, that is, the belting made soft and pliable, treated with "Cling-surface," the equalising weights are 7 lb. each, the weight added being 84 lb., then the coefficient of friction in this case will be:—

$$\frac{84}{84 + 7 + 7} = \frac{84}{98} = 0{\cdot}85$$

It therefore follows that the chief end to attain in belt driving is a full measure of grip, and the more soft and supple a belt is, the better will be its grip to the face of the pulley, and the more power will it deliver.

Iron Ores in Normandy. The Société Française des Aciéries Basset announces its intention of erecting large works in Normandy for treating locally the iron ores found at Surques, Bourberouge, and Mortain. By the Basset process steel can be obtained by direct treatment, without blast furnaces.

The United States Attorney General has ordered an investigation of the alleged price fixing combination of building material manufacturers, and a quiet investigation along the same lines is being conducted in New York by the Attorney General of the State.

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By Eric M. Bergstrom, of London.
Associate Member of the Institution of Mechanical Engineers.

(Continued from page 11, October 22.)

Speed Regulation.

The development of the design and construction of governors has naturally been closely bound up with the general advances in the design of Francis turbines. The old type of mechanical governor proved totally inadequate for the needs of efficient speed-control in connection with hydraulically driven generators. As a consequence, the hydraulic type of governor was evolved, which, in the first place, was actuated by the water pressure, but later was substituted by oil pressure in order to eliminate several bad features of the water-pressure governor, that is, sticking due to gritty water, and liability to corrosion of the various mechanical parts. Although a large number of oil-pressure governors have been introduced, all embodying different mechanical construction, the same principle of opera-

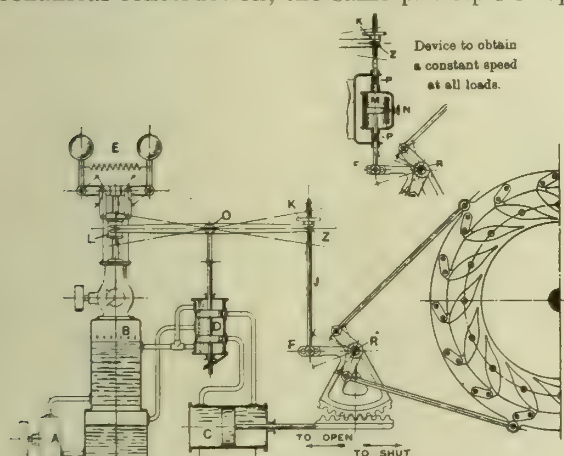


Fig. 23.—Diagram showing the principle of an Oil-pressure Governor.

tion has been retained as is shown diagrammatically in Fig. 26, where A represents oil-pump, B oil-pressure receiver, C servo-motor or hydraulic cylinder, D distributing valve, E centrifugal pendulum, and F relay motion or anti-racing mechanism. The pump, as well as the pendulum, is driven from the turbine shaft, and if the turbine is running at its normal speed the pendulum is so adjusted that the sleeve L, as well as the distributing valve O, would be in the central positions as indicated on the diagram. If, however, the load on the turbine should decrease and consequently the speed increase, the sleeve L, as well as the distributing valve O, would through the lever O with Z as a fulcrum, causing the oil-pressure from the pressure-receiver to be admitted on the left side of the servo-motor piston and moving the guide-vanes in the closing direction through the governor-shaft R. At the moment the shaft R starts to turn, however, the lever F will move, in this instance downwards, and lower the connecting-rod J, consequently bringing the distributing valve back to its central position through the lever O with the point L as a temporary fulcrum. The pressure supply to the servo-motor is thus cut off and prevents the gates on the turbines from closing further than necessary to establish equilibrium between the load and corresponding output of the turbine. By means of the small hand-wheel K on the relay motion, the connecting-rod J can be either shortened or lengthened, thus enabling the speed of the turbine to be slightly decreased or increased during running, independent of the load.

The distributing valve in Fig. 27 shows a typical design, the relay-valve being entirely balanced by oil pressure in its central position. The pilot-valve, however, controls the oil pressure on both sides of the relay-valve, and when lifted or lowered by the governor pendulum, relieves the oil pressure either at the top or bottom of the relay-valve, thus permitting the pressure oil to enter the servo-motor. As the relay-valve is floating in oil, the friction is infinitesimal, and as the valve only overlaps less than 1 mm. at the ports, the "dead time" is brought to a minimum and consequently the action of the governor is instantaneous. By restricting the stroke

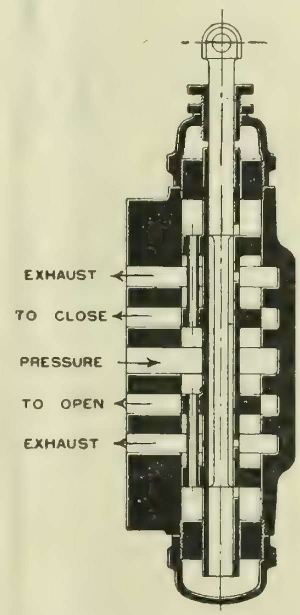


Fig. 24.—Distributing Valve for Oil-pressure Governor.

of the relay-valve by the screw on the top of the valve, the pressure is throttled, and by this means the closing time of the governor is adjusted.

In some types of governor the oil-pressure receiver has been dispensed with, the pump being made large enough to supply the necessary oil under pressure required for the servo-motor to make its full stroke within the closing time for which the governor has been designed. The pressure under which the governor operates is from 150 lb. to 200 lb. per square inch, and obtained from a rotary pump driven from the turbine shaft. In addition to the constant-speed compensation, the modern oil-pressure governor is equipped with an adjustable equalising device permitting the degree of irregularity to be adjusted within certain limits, which enables the turbine to run in parallel with alternators driven by steam-engines, the governor being adjusted for the same degree of irregularity as the governor-head on the engine-regulator.

The arrangement of such a pressure regulator is shown diagrammatically in Fig. 28. Simultaneously

as the governor closes the guide-vanes, the piston B in the oil dashpot cylinder A is lifted. The valve is connected to the cylinder which contains a passage allowing the oil to pass from one side of the piston to the other, the rate of flow being adjusted by a small needle valve. When the piston B is lifted the cylinder will follow, and consequently the valve will open at the same rate as the governor closes the turbine. The cylinder is, however, loaded with a heavy weight which exerts a pressure on the oil, which will slowly flow to the lower side of the piston and gradually allow the valve to be closed. By means of the needle valve the rate of closing is regulated sufficiently slowly to prevent any dangerous shocks in the pipe line.

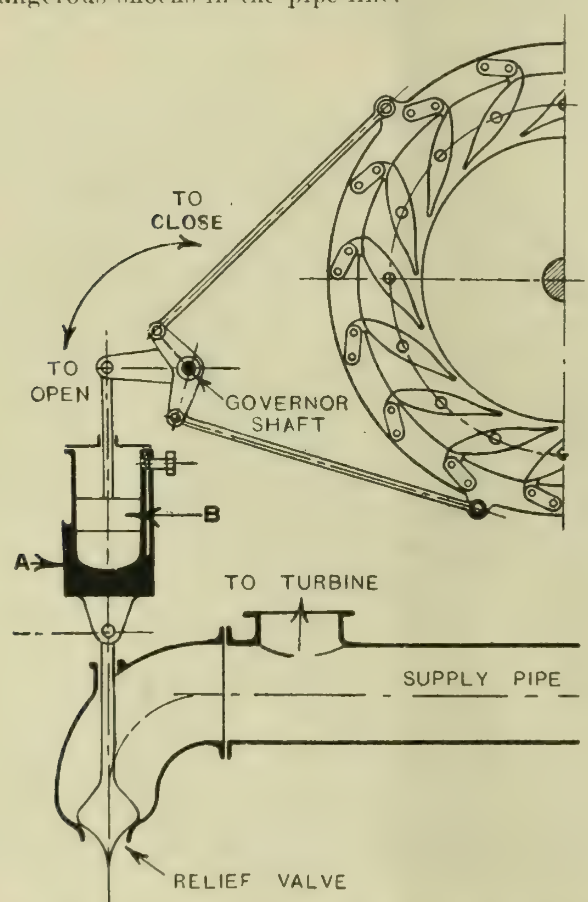


Fig. 25.—Governor-operated Relief Valve as applied to Turbines.

Pelton Wheels.

The second category comprises the high-pressure impulse turbine more familiarly known as the Pelton wheel, and is of the purely impulse type, the water issuing from a nozzle at the full velocity corresponding to the net head and impinging on a set of buckets bolted on to the rim of the wheel centre. The Pelton wheel is used under heads varying from about 500 ft. to 2,000 ft., although for small powers it can be used under medium heads of down to 100 ft., and, on the other hand, has been employed under a maximum of 5,400 ft. in one stage.

The chief characteristic of the impulse wheel is the long range of load during which the efficiency is nearly constant as can be seen from the efficiency curves reproduced from official tests, Fig. 29. In each case the efficiency at half load is over 85 per cent, and only falls below 80 per cent when the load is less than 30 per cent of the normal. To obtain the maximum efficiency the ratio between the pitch diameter of the wheel and diameter of the jet should not be less than 12, although in certain cases a ratio of 10 : 1 may be used when a higher speed is secured at the expense of efficiency.

The original Pelton buckets were rectangular in section, Fig. 30, but have been superseded by the elliptically-shaped bucket which has now been universally adopted by all makers, as the absence of sharp corners and abrupt changes of direction of the stream favours the reduction of the hydraulic losses. The same tendency to adopt a uniform design is also noticeable in respect of the nozzle where the various designs of rectangular nozzle with movable lip have been discarded in favour of the circular

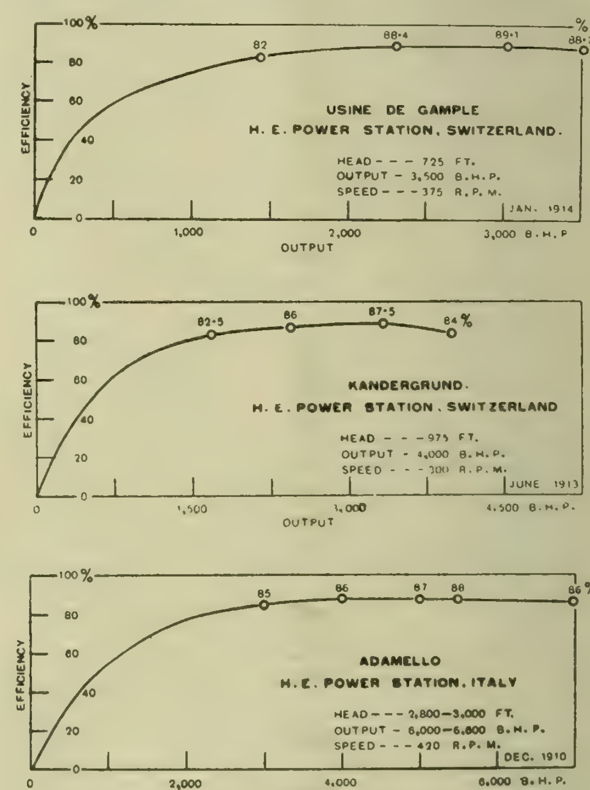


Fig. 26.—Pelton Wheels. Efficiency Curves.

nozzle with concentric pear-shaped spear or interceptor movable in axial direction for regulating the quantity of water, Fig. 31, which now without exception is employed in modern Pelton wheel design. The most important improvement, however, is in respect of the system of regulation which, as in the case of the Francis turbine, had to be adapted for the new conditions of electrical transmission, and at the same time conform to the increased demand for accurate and reliable automatic governing.

Three distinct systems of automatic governing are now employed, namely:—

(A.) By-pass valve regulation.

(B.) Regulation with deflecting nozzle.

(C.) Combined spear and deflector regulation.

The object aimed at in each of these methods of automatic control is to obtain an instantaneous regulation of the quantity of water in response to

any load changes, at the same time ensuring a slow and gradual retardation of the flow in the pipe line to obviate any dangerous increase in pressure.

The by-pass regulation is the oldest type used in combination with the automatic governing of Pelton wheels, and, as indicated by its name, consists of a by-pass valve the principle of which has already been referred to in connection with high-pressure Francis turbines. The regulating shaft on the oil-pressure governor of the standard type acts direct on the movable spear of the nozzle, instantaneously establishing equilibrium between the quantity of water reaching the wheel and the load on the turbine. At the same time, in case of a sudden throwing off of the load, the by-pass valve will open at the same rate as the spear closes, and then close slowly by the pressure of a spring against the dashpot. As the quantity of water is usually small, the by-pass valve consists of a needle valve directly operated by the governor. For Pelton wheels for large outputs and comparatively low heads, employing two runners with two or more jets, and consequently a large quantity of water the by-pass valve is generally operated indirectly by the governor in the same manner as the relief valve in connection with Francis turbines. Although the by-pass regulation has been employed in a large number of plants, the inherent defect of liability to stick and excessive wear, together with the difficulty of ensuring synchronising action, called for further improvements in design resulting in the introduction of the deflecting nozzle; in this construction the complete nozzle is pivoted on its perpendicular axis and deflects the whole or part of the jet from the wheel and discharge direct into the tail race. A number of plants have been equipped with this particular regulating device, with highly satisfactory results, but in recent years the combined spear and deflector regulation has come to the front, and on account of its simpler design and cheaper construction has now been adopted in the most modern plants. The main feature of this design is the deflecting hood or shoe known as the "deflector" interposed between the nozzle and the wheel and pivoted in such a position that direction of the jet can be altered.

Pelton. Doble.

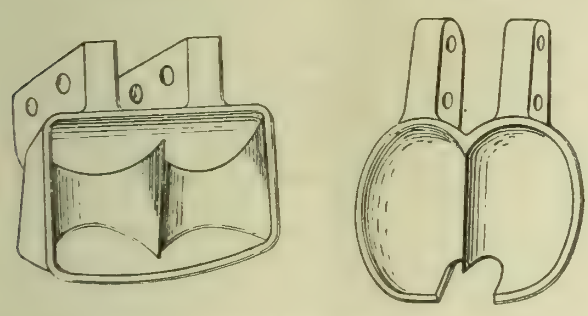


Fig. 27.—Buckets for Impulse Turbines.

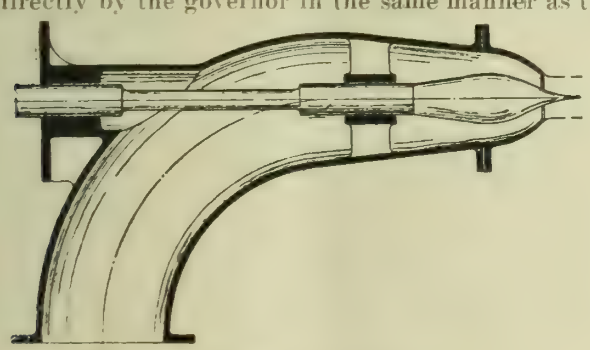


Fig. 28. Pear-shaped Nozzle.

(To be continued.)

THE INSTITUTION OF AUTOMOBILE ENGINEERS.

THE AUTOMOBILE STEEL RESEARCH REPORT.

On the 10th inst., Mr. J. H. S. Dickenson, member of the Council of the Institution of Automobile Engineers and chairman of the Executive Research Sub-Committee, read a valuable paper before the Institution dealing with various points in regard to the report which has just been issued. After a few historical references to the initiation of the research, he pointed out that the heat-treatment and the mechanical testing were carried out in all cases by different investigators, and that nearly every test was made by at least three different investigators.

He then dealt with the method adopted by the committee of dealing with the discrepancies which occurred in the test results returned by the various investigators, indicating that similar discrepancies are likely to occur in ordinary everyday shop practice. For the purpose of the report the committee had, in addition to publishing the figures as given by the investigators, showed a series of what they termed "X," or "representative" figures, so that by noting the general tendency of the curves obvious errors could be eliminated and smaller discrepancies allowed for; thus these figures really give an indication of what may be expected from the various steels in everyday use.

The author points out that two different casts of each of the ten steels were tested, so that the steels of both the higher and the lower limit of composition might be studied. The steelmakers generously provided samples of all these 20 steels free of charge, the majority of them coming very close to the analyses laid down by the Committee and set out in the report.

A special series of standard test pieces, both for tensile, Izod and Charpy tests, were laid down by the committee for the research, and the tests were carried out on bars of 1⅛ in. diameter, as being the size representing a large proportion of automobile parts, though tests were also made on pieces up to three inches diameter, with a view to discovering the influence of mass upon test results.

The author then proceeded to draw attention to various anomalies and points arising from the figures given in the report, which can hardly be given in detail, but which should be studied by those interested in the report itself, which is published by the Institution of Automobile Engineers, 28, Victoria Street, S.W.1.

The report, it should be added, contains coloured charts showing the test results from all the 20 steels, together with heating and cooling curves, the standard test pieces adopted, and all the investigators' figures. It should indeed be a work of the utmost value, not only to automobile engineers, but to all engineers who require to use special steels.

GRADUATES' VISIT.

The London graduates of the Institution of Automobile Engineers paid their first visit of the session to the works of the Associated Equipments Co., at Walthamstow, on October 23rd. The party, consisting og about 20, were conducted by Messrs. Macklin, Pile, West, and Roberts through the works, the erecting machine and running shops being visited in turn. Most interest was shown in the testing laboratory, where notched bar and ductility tests were demonstrated. It is hoped that it may be found possible later in the session to arrange some visits on week-days, so that the graduates may have the opportunity of seeing the works in actual operation.

It is announced that the graduates' annual dinner and social evening will be held on Saturday, February 5th, 1921. Tickets, single 15s., double 21s., may now be obtained from the hon. secretary, Mr. D. J. Macklin, 54, Maldon Road, Acton, W.3. As the number of tickets is limited, all intending to be present are advised to secure their seats as soon as possible.

E.P.D.—Subscriptions of members of the Commercial Motor Users' Association are allowed to be deducted in computing the liability of individuals to Excess Profits Duty.

AMERICAN ENGINEERING NOTES.

Trouble with coal miners, threatened coal shortage, and America's future as purveyor of petroleum have been so much to the fore for so long a time that those who concern themselves with posterity are voicing timid fears of the country's future. While politicians, diplomats, and administrators are stumping the country in the effort to persuade the people to give them a mandate next month, which will enable them to hang on to office, the real leaders of the country are considering practical problems. I met our Ambassador to Great Britain recently, just before he delivered an excellent argument in favour of the League of Nations. One of the outstanding industrial problems is the practical development of our latest water powers, as an insurance against industrial dislocation arising from recurring coal strikes.

* * *

On this subject Mr. W. S. Murray, chief engineer of the Super-Power Survey, in an address before the Water-Power League of America, stated that by the development of waterways in the East between Washington and Boston, and converting the energy of rivers and streams into horse-power, an annual saving of 300,000,000 dols. to manufacturers and railway companies would be accomplished. Mr. Murray also emphasised the enormous waste of power under the prevailing system of small unit steam generation, adding that the proposed system of combined hydro-electric and steam central power plants would "treble" the available horse power of this Eastern region. Plans already made have gone so far as to locate tide-water points, where generating stations designed to form the backbone of the super-power system might be erected. One man, at the Water-Power League meeting, repeated the oft-made statement that within ten years this country would be purchasing 500,000,000 barrels of oil annually from Great Britain. On the other hand, another authority on the subject ventured the opinion that so far only the surface of the world's hidden oil reserves had been uncovered.

* * *

It may be of passing interest to relate that Herbert Hoover, our erstwhile Food Controller, will serve as consulting engineer on the Board which is to assist the Government in the working out of its plans for the Boston to Washington part of the ultimate nation-wide power system. Enthusiasm and modesty of assertion seldom run together, even outside a company prospectus. And the super-power men are enthusiastic. Their rosy pictures pale somewhat in the cold light of the official conclusions given in a Government report, which says "it appears to be true that the gain which would result from a conservation of the national fuel supply and a full utilisation of the national water resources would be 'public and future' rather than 'private and present.'"

* * *

It is to be remembered that fuel saving would be largely counterbalanced by the present high cost of hydro-electric construction, except in specially-favoured locations, and under the most advantageous physical conditions. Frequently storage capacity of a costly character have to be provided. Long distance high-tension transmission lines to be laid, water rights to be acquired, and, moreover, the distance over which electric power can be profitably transmitted is limited.

* * *

Nevertheless, the ingredients from which a fascinating industrial picture may be painted are abundant. The official estimates—the full report I sent to the *Industrial Engineer* a week or two ago—places the minimum horse-power of the waterways of the United States at 27,000,000, and the maximum somewhere between 52,000,000 and 60,000,000, of which a total of 7,000,000 has, so far, been harnessed. The country in 1917 used approximately 30,000,000 horse power, derived from steam, water, and internal-combustion engines, it being estimated that if this amount of power were supplied by water there would be an annual fuel saving of some 2,000,000,000 dols., and a further saving running into hundreds of millions in wages. A truly attractive prospect, in more or less fugitive colours, as they are mixed to-day. To-morrow may tell a different story.

* * *

Following is a synopsis of Mr. Murray's reasons for a super-power system:

(*a*) High load factor is conducive towards economy in all classes of business. The business of power generation and distribution is no exception to this rule.

(*b*) The load factor in railway, lighting and industrial operations, which are individual to themselves, is low.

(*c*) The production of power through the agency of small units is uneconomical.

(*d*) A very considerable diversity in maximum power production exists in the three classes mentioned under (*b*).

(*e*) The production of power by large units is highly economical.

(*f*) The supply of power from a common bus to the railways and industrials offers opportunity to supply it from large generating units at high load factor and a unionised system of such a character permits maximum use of water-power development.

* * *

There is active, strong and growing interest, both in this country and Canada, in the project for improving the St. Lawrence. Aside from the interest of shipping men and farmers in it, there is another interesting feature in connection with it of particular industrial interest. The river falls 91 feet in the 65 miles of the international section, of which 48 feet is in 12 miles, and in the Canadian section it falls 130 feet in 70 miles, of which 129 feet is in two stretches of 14 and 8½ miles each. It is estimated that improvements which would make the river navigable could be made to produce approximately 4,000,000 H.P.

* * *

Conservation is indeed in the air. The Bureau of Mines, in a statement on petroleum, points out another neglect which goes to make "waste" the great national sin of America, when it says: "The entire preventive losses in the evaporation of gasoline from crude petroleum from the time the petroleum leaves the wells until it arrives at the refineries reaches a total of more than 300,000,000 gallons each year, or sufficient to keep 1,200,000 automobiles in commission for a year, if each car uses 250 gallons.

* * *

In our older oilfields of Pennsylvania it has been found that compressed air forced into the oil sands of semi-exhausted oil wells is increasing their output from 50 to 100 per cent.

* * *

According to *Oil News*, Professor C. M. Sutton, geologist and scientist, of Shreveport, Louisiana, is the inventor and owner of an electro-chemical instrument which he declares is 100 per cent efficient in locating oil pools. The professor stated that a syndicate with a capitalisation of 200,000,000 dols. has been formed by eastern capitalists and his instrument is to be used by the syndicate in locating productive fields. The machine is grounded, says its originator, and certain chemical properties in the oil and gas cause it to "register." It does not work on metalliferous deposits, he says.

* * *

From oil and automobiles it is a short step to steel. And the steel trade in Pittsburg is resenting rather heatedly efforts which it is convinced are being made to create in the public mind an impression that steel prices can be so far reduced as to take care of the reductions now being made in automobile prices. Comparisons are being made between prices per pound of finished cars and the prices per pound of the steel that makes up something like one half of their weight. Roughly, the lighter cars have cost 50 to 75 cents a pound; medium-priced cars about one dollar; and a few high-priced makes two dollars a pound, the steel in them costing from 2¼ cents to 6 cents a pound. While these figures are not exact, they do go to show the absurdity of thinking that steel prices can have any such relation to the price of cars as to account for some hundreds of dollars difference in price.

* * *

More than 50 coal-mining undertakings, most of them new developments, have been mentioned in southern mining circles during the past week. West Virginia had 28 and Kentucky 23 of them.

* * *

Reverting to steel, opinions as to conditions seem wide apart. Our August iron and steel exports were 3,000,000 dols. less than July. A leading official of the export agency of the leading independent steel mills said that our trade abroad was "all shot to pieces." Schwab says lower prices will make for normal operations of the mills, while Gary, just back from abroad, tells us that the steel position is "sound." At any rate, his company, the U.S. Steel Corporation, reported unfilled orders at the end of last month reduced by 430,234 tons.

* * *

Licensed marine engineers to the number of 14,000 on the Atlantic and Gulf coasts have been refused their demand for increased wages and overtime pay

Trade Items, Notes, &c.

Motor Haulage Contractors.—The Commercial Motor Users' Association has made arrangements under which motor haulage contractors who desire to send their motor lorries to the Continent for work may do so without having to deposit cash in respect of the 70 per cent *ad valorem* Customs duty.

The Secretary of the Department of Scientific and Industrial Research begs to announce that a licence, under Section 20 of the Companies' (Consolidation) Act, 1908, has been issued by the Board of Trade to the British Motor Cycle and Cycle-car Research Association, which has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The Association may be approached through Major H. R. Watling, "The Towers," Warwick Road, Coventry.

Electrification of Swedish Railways.—The *Stockholms Dagblad* reports that the Railway Department have placed before Parliament a Bill requesting the sum of Kr.26,000,000 be allotted out of the 1922 funds for the electrification of the line from Stockholm to Gothenburg. The total cost of the undertaking will be Kr.75,000,000. According to this year's Budget, the Railway Department have already been allowed a loan of Kr.23,000,000 out of the 1921 funds, and as the total grant is to be spread over a period of two years, the sum of Kr.26,000,000 should, it is proposed, be included in the 1923 Budget.

London Association of Scale and Weighing Machine Manufacturers (Incorporated).—Registered October 25th, as a company limited by guarantee, the word "Limited" being omitted from the title by licence of the Board of Trade. Objects : To promote the interests of persons, firms, and companies engaged in the manufacture, repair, and maintenance of scales, weights, weighing machines and instruments in London, Middlesex, Surrey, Essex, Sussex, Herts, Bucks, or Kent; to take over all or any of the liabilities of an unincorporated association of same name. The management is vested in a committee, the first members of which are : A. Fitzherbert (president), H. E. Titford (deputy chairman), A. H. Grace (hon. treasurer), F. Wakeham (hon. secretary), G. H. Corderoy, J. McIntosh, T. S. Chayney, J. Doyle, E. A. Hart, W. A. Herbert, junr., H. J. Marlow, W. H. Mattocks, C. Baker Minton, and C. Berry. Registered office : 6, Holborn Viaduct, E.C.

It is of great interest to learn that the Scottish Universities have included for the first time aeronautics in their engineering course this year. At Gilmorehill, in Glasgow, what is known as a "half-graduation" course consisting of 12 lectures will be given on this subject. The course has been mapped out in collaboration with the officials of the Scottish branch of the Royal Aeronautical Society, and the services of very able men have been secured to deal with the different features. Mr. L. Bartlett, of the Royal Corps of Naval Constructors, who is at present stationed at the Inchiman Airship Construction Works of Messrs. William Beardmore & Co. Ltd., has undertaken lectures dealing particularly with rigid airships. He will deliver two lectures in Glasgow, two in Edinburgh, and one in Dundee, on the subject of "Rigid Airships : Design and Construction." These will be illustrated by a series of lantern slides, showing diagrams and photographs of construction, which have been prepared by Messrs. Beardmore specially for the purpose.

The electrically-welded coasting vessel, the "Fullagar," built by Cammell, Laird & Co. Ltd., was fitted with the first marine oil engine of the "Cammellaird-Fullagar" type, designed to develop about 500 B.H.P. In the course of exhaustive trials of both the hull and the machinery, the vessel proved very satisfactory, and was sold to T. and J. Brocklebank Ltd., Liverpool. Since then she had done nearly 10,000 miles in constant service, during which the engine has proved most satisfactory, giving practically no trouble and developing more horse power than had been anticipated. The engine being more powerful than necessary for a coasting vessel of the size of the "Fullagar," Messrs. Brocklebank have, *Engineering* states, placed an order with Messrs. Cammell Laird for a similar engine in all respects; when this is completed, the two units—the one at present in the "Fullagar" and the new one—will be installed in a twin-screw vessel of about 4,000 tons now under construction. The "Fullagar" engine will be replaced by machinery of much less power, which will meet all the requirements of the coasting trade.

PUBLICATIONS.

The House of Griffin.—The industrial world owes a great debt of gratitude to the firm of Charles Griffin & Co. Ltd., who have for the past 100 years paid particular and marked attention to the publication of technical literature. Although such publication may be made a paying proposition, it does not hold out the same attractiveness as publishing fiction, as the number of potential buyers is generally limited. The value of good technological books cannot be over-estimated, and the great need for technical libraries is now being felt more than ever. The various research associations are finding that, although technical books on particular subjects have been published, the libraries—except private ones—do not possess a great many that are essential and vital. The firm of Griffin has undoubtedly played a big part in providing the industries with technical literature. As is pointed out by Lord Moulton in a foreword to Griffin's centenary volume, "the reputation and success of the firm has been due to the good fortune which has given it in unbroken succession an able and enterprising head." The volume referred to traces the progress marked by Griffin's publications during the last 100 years. A number of very able articles are contributed by William Garnett, M.A., D.C.L., T. Hudson Beare, B.A., M.Sc., etc., Sir W. S. Abell, K.B.E., etc., and others. They deal with various technical subjects—engineering, naval architecture, metallurgical assaying, mining, chemical technology, and textile industries, and record the most important technical works issued by Messrs. Griffin on these subjects. The list even of these is most lengthy, and one can assuredly say that during its hundred years of life the firm has done a lasting and noble work for industry in this country.

Alfred Herbert & Co.—This firm are selling agents for the Norton Company, and they have forwarded a brochure of the Norton grinding wheel, which gives illustrations and dimensions of grinding wheels in common use. It is in 24 pages, and should be of great assistance when ordering grinding wheels.

The Cambridge and Paul Instrument Co. Ltd. have sent us their leaflet No. 957, which deals with their electrical CO_2 apparatus, which is a new apparatus for indicating or recording the percentage of carbon dioxide in flue gases. Reproductions of actual records obtained with the recorder are also to hand in leaflet form.

REVIEWS.

THE DESIGN AND CONSTRUCTION OF REGENERATIVE REVERBERATORY GAS-FIRED REHEATING FURNACES. By J. W. Spedding. Manchester : John Heywood Ltd.

This is a report of a lecture delivered before the Association of Engineering and Shipbuilding Draughtsmen. It is very practical, and its 42 pages are profusely illustrated with line drawings. It is an attempt to supply the necessary data required for designing the type of reheating furnaces, and explains in detail how the proportions for different parts of the furnace are arrived at.

SLIDE RULES: HOW TO USE THEM. By Thomas Jackson London : Chapman & Hall Ltd., 11, Henrietta Street. 1s. 6d. nett.

A brief and lucid explanation of the slide rule. In the first part of the book the general principle is discussed, and the method of using it to solve problems of division, proportion, etc. The remainder of the book describes the various makes of slide rules. A useful little book.

THE INTERNAL-COMBUSTION COMMERCIAL VEHICLE. By James Watt, M.I.A.E.

This is one of a series of pamphlets which are being issued by the Association of Engineering and Shipbuilding Draughtsmen, and can be purchased from the General Secretary, 96, St. George's Square, London, S.W.1. The author, in his introduction, correctly points out that the realm of the self-propelled vehicle is so immense that in a pamphlet of some 40 pages it is impossible to deal fully with all the units that go to make a chassis, consequently he confines himself to the actual design of the transmission, control mechanism, weight-supporting members, and carriage appendages. The author is very practical, and the pamphlet gives much information that should be useful not only to designers, but to all engineers who are interested in commercial vehicles.

FOREIGN NOTES.

Special Steel for Germany.—The importation of ferro vanadium and ferro-chrome, which has so far not been allowed to exceed 1·5 per cent of the total steel imports, is now free till further notice. Permission is given to import up to 30 tons of wolfram per month, so as to enable the requirements of German producers to be met.

Finnish Plan for the Establishment of Large Power Works.—*Svenska Dagbladet* learns from Helsingfors that the Finnish Government is preparing plans for the efficient utilisation of the water power of the country for industrial purposes. It is intended to establish a large power works, which will supply the entire South of Finland.—Reuter.

Discovery of Oil in France.—A message from Saint-Sever states that investigations carried out by two well-known geologists have led to the discovery of a layer of petroleum in the communes of Bancs and Montaut, extending over some 800 hectares. A meeting of landowners has been held at Montaut for the purpose of authorising borings.—Reuter.

New Stabilisers: Test by the United States Navy.—Ship stabilisers, which, it is claimed, will prevent a vessel from rolling in the seaway, will be given tests in all kinds of stormy weather in a two months' experimental cruise by the naval transport Henderson. The vessel left the Philadelphia Navy Yard recently. The stabilisers, which act on the principle of the gyroscope, are two 30-ton electrically-run flywheels, placed deep in the vessel, close to the keel. By a delicate electric control, the slightest motion of the ship is recorded, and the stabilisers are moved so that their own force will oppose that of the wave acting on the ship.—Reuter.

Copper in Madagascar.—Copper is still so far not exploited to any important extent in Madagascar, although its presence has been noted at several parts of the island, and in spite of the fact that numerous concessions have already been granted for working this ore. Some few thousands of tons, containing 12 per cent ore, have, however, recently been brought to the surface at Ambatoafangana. Some samples of ore, from the province of Vohema, have shown as much as 15 per cent of copper upon analysis. It is firmly believed that, in a not far distant future, Madagascar will rank amongst the important copper-producing countries.

Restoration of Russian Locomotives.—The *Chemnitzer Allgemeine Zeitung* learns from industrial circles in Essen that the Soviet Government is on the point of concluding contracts to the value of 600,000,000 gold marks with German firms for the construction of locomotives for the Russian railways. The payment of the money is said to be guaranteed by two foreign banks. It is stated that the contracts were first offered to British firms, but their prices were too high. The contracts will be carried out by a German group, which includes the firms of Hartmann (Chemnitz), Borsig (Berlin), Massei (Munich), and Krupp (Essen). According to the *Berliner Zeitung*, some financial difficulties have still to be cleared up.—Reuter.

New Swedish Invention for the Utilisation of Wind Power.—A new company has been formed at Stockholm for the purpose of taking over and exploiting an invention of Mr. A. Boalt and the engineer, J. H. Sandberg, for the utilisation of wind power. The new appliance enables wind motors of the usual type to utilise wind of varying degrees of strength, a system of water regulation being employed in order to obtain a constant number of revolutions and accumulate the energy thus produced. The invention is intended for application to wind motors of any type, and by combining an entire system of motors with water cisterns a large electric power plant can be formed. The new system should thus prove particularly useful in places where there is a lack of water power. The founders of the new company are the inventors, Mr. Sven Aronsson, Professor W. Fallenius, and Dr. J. Lindquist. The minimum share capital is fixed at Kr.500,000 in Kr.1,000 shares.—Reuter.

The Iron and Steel Industries in Sweden.—*Svensk Handelstidningen* learns that an official expert, in a report on the Swedish iron and steel industries, says that he considers the prospect far from good, and questions whether these industries will ever attain their pre-war development. The difficulties they experience are chiefly in connection with the high cost of manufacture, especially the enormous prices for fuel. In 1913, for instance, it cost Kr.80 to manufacture one ton of pig iron, whereas in 1918 it cost Kr.285. Wages, moreover, are expected to rise still further, and the introduction of the eight-hour day has involved a direct increase in the cost of production. The export situation, continues the writer, is still more unfavourable. Owing to the discontinuation of Swedish exports during the war, a considerable number of previous buyers of Swedish iron and steel took up manufacture on their own account and learnt to rely on their own materials. It is therefore uncertain whether Sweden will ever regain the whole of her former export market. —*Reuter.*

Bochumer Verein fuer Bergbau und Gussstahlfabrikation.—The following occurs in the report presented to the shareholders by the Board of the Bochumer Verein fuer Bergbau und Gussstahlfabrikation: "Although there has never been any doubt that the wounds sustained by our national industries could only be healed by a rapid and considerable increase in production, the contrary unfortunately has been the case during the year under review, output having declined while salaries and wages especially have mounted still higher. In the previous year we pointed out that the shadow of a coming lack of coal was already threatening. Our fears have proved to be only too well grounded, witness the Spa agreement, and in spite of the fact that we have taken the precaution at great expense and risk of acquiring a few coal mines, we, like others, shall undoubtedly have to suffer greatly from the scarcity of fuel. We are making it our constant endeavour to limit the use of coal, but our success in this matter is considerably hampered by the fact that the machinery for the production of steam and electric power greatly deteriorated during the war. A more advantageous use of fuel can therefore be obtained only gradually and at great cost. The list of orders on hand at the steel works on July 1 last may be considered satisfactory. As for the prospects of the current year, we are not in a position to make any forecasts. We can only repeat that the results will depend on the further developments of political and economic conditions." As previously reported, the Bochumer Verein is paying a dividend on the last financial year's working of 15 per cent, as compared with 5 per cent for the previous year. —Reuter.

Commercial Wireless Scheme in Australia.—Proposals for extending commercial wireless services to Australia were explained by Sir Thomas Hughes, M.L.C., chairman of the Board of Amalgamated Wireless (Australasia) Ltd., at the annual meeting of shareholders recently. After outlining briefly the steps taken in other countries to link up for commercial purposes, the chairman stated that the directors had submitted to the Government a comprehensive scheme for a direct wireless service between Australia and England. This consisted broadly in a high-speed, duplex-operated station near one of the capital cities, to communicate direct with a corresponding station in England, together with medium power-feeding stations near each of the other capital cities to pass traffic to and from the main trunk station. This system would be radically different from anything existing in Australia to-day. Both the main trunk and the feeder stations were to be operated by distant control from the heart of the cities, and all stations could communicate simultaneously with the main trunk system without interference, while the main trunk would at the same time be sending to, and receiving from, England. By this means they were able to offer an efficient, speedy and reliable service between all parts of Australia and England. They had offered to handle all classes of messages at one-third less than existing rates, and to give the Commonwealth Government 25 per cent of net profits, to have the stations working in two years, to hand them over in any time of national danger, to surrender them to the Government free of all payment at the end of a term of years, and to give the Government right of resumption at all times. Their feeder stations at the same time could cater effectively for ordinary commercial ship to shore traffic, thus giving an improved service for shipping and passengers, and saving the Government at least £20,000 per annum. Subject to the foregoing, the company asked that a licence be granted it, but there was nothing in their offer nor in the conditions of wireless working to prevent other companies having similar privileges. Sir Thomas Hughes added that the company hoped to give some demonstration of long-distance wireless telephony in Australia during the current financial year.

New Companies.

Wallace (Glasgow) Ltd. Registered in Edinburgh, August 3rd. Capital, £1,000,000 in £1 shares. To acquire the undertaking of Wallace Farm Implements Ltd., and of its subsidiary companies, John Wallace & Sons Ltd., The D. L. Motor Manufacturing Co. Ltd., and the Carmuirs Iron Co. Ltd., as at January 1st, 1920, to complete the purchase of the National Projectile Factory, Cardonald, Glasgow, to enter into an agreement with the Single-Sleeve Valve Syndicate, etc. Directors: D. M. Wallace, D. W. T. Cangill, J. C. Duffus, W. Guthrie, J. N. Reynard, G. B. Shields, and W. B. Wallace. Registered office: 34, Paton Street, Glasgow.

John Saunderson & Son Ltd. Private company. Registered July 29th. Capital, £7,000 in £1 shares. To carry on the business of manufacturers of and dealers in silver and gold-plated and electro-plated goods, cabinet cases, cutlery, metal goods, etc. The first directors are: H. D. Cass (managing director), A. E. Shaw, and S. Neill. The two first-named are permanent. Registered office: 21-3, Westfield Terrace, Sheffield.

Surrey Scientific Apparatus Co. Ltd. Private company. Registered July 28th. Capital, £5,000 in £1 shares. To carry on the business of electricians, electrical engineers, manufacturers of electrical apparatus, comprising electrical, telegraph, telephone, wireless, scientific, etc. First directors not named. Registered office: 101A, High Street, Mortlake, S.W.

New Eagle Foundry Co. Ltd. Private company. Registered July 29th. Capital, £3,000 in £1 shares. To carry on the business of iron and brass founders, metal casters, etc. The first directors are: G. Finney, W. Finney, J. Finney, A. Evans, W. James, and H. F. Dane. Registered office: Birkby Street, Birmingham.

Lowth & Smith Ltd. Private company. Registered October 22nd. Capital, £5.000 in £10 shares. To take over the business carried on at 3, Hanging Ditch, Manchester, as "Lowth & Smith," and to carry on the business of electrical and mechanical engineers, etc. The permanent directors are: W. H. Lowth and T. Smith. Registered office: 3, Hanging Ditch, Manchester.

Urquhart's Ltd. Private company. Registered October 23rd. Capital, £5,000, in 4,600 ordinary shares of £1 each and 8,000 deferred shares of 1s. each. To take over the business of a manufacturer, seller, and installer of oil fuel burners carried on by G. U. Morgan, at 77, Belgrave Road, S.W. The first directors are: M. Whitewell, junr., D.S.O., M.C., G. U. Morgan, O.B.E., A.M.I.M.E., M.I.M.E., and G. A. Clavey. Secretary: J. C. Dobbin. Registered office: 77, Belgrave Road, Victoria, S.W.1.

F. W. Tattersall, Ltd. Private company. Registered October 21st. Capital, £1,200 in £1 shares. To take over the business of a cycle agent, ironmonger and hardwareman carried on by J. Condliffe at Liverpool Road, Kidsgrove, Staffs. The first directors are: F. W. Tattersall and Mrs. A. L. Tattersall. Secretary: F. W. Tattersall. Registered office: Liverpool Road, Kidsgrove, Staffs.

Leeds Builders Ltd. Private company. Registered October 22nd. Capital, £1,000 in £1 shares. To carry on the business of builders, railway and general contractors and repairers, iron founders, smiths, etc. The first directors are: A. Pettitt and H. S. Pettitt. Qualification: £50. Registered office: 63, Albion Street, Leeds.

James Turner & Davenport Ltd. Private company. Registered October 22nd. Capital, £20.000 in £1 shares. To take over the business of cutlery manufacturers and merchants carried on by J. Turner and J. F. Robertson in Sheffield and elsewhere, as "James Turner." The permanent directors are: J. Turner and J. F. Robertson. Secretary: A. L. Roberts. Registered office: City Works, 106, Mary Street, Sheffield.

Vickers (South Africa) Ltd. Private company. Registered October 22nd. Capital, £10,000 in £1 shares. Metal founders and workers, shipwrights, builders, and repairers of war and other ships, including submarines, dealers in machinery, tackle, ship's furniture and stores, manufacturers of and dealers in guns, gun carriages, torpedoes, ordnance, electricians, electrical engineers, etc. The first directors are: F. H. Barker, S. V. Bardier, and N. Robinson. Secretary (*pro. tem.*): C. E. Bardier. Office: Vickers House, Broadway, Westminster, S.W.

Oystermouth Garages Ltd. Private company. Registered October 22nd. Capital, £5,000 in £1 shares. To carry on the business of motor, aviation, marine, and general engineers, etc. The first directors are: E. Lewis and J. Jackson. Registered office: Norton Lane, West Cross, Swansea.

Mortgages, Charges, Satisfactions.

Fastnut Subsidiary Ltd. First mortgage debenture dated October 20th, 1920, to secure £10,000, charged on the Beehive Wharf, Brentford, plant, machinery, and the company's undertaking and property, present and future, including uncalled capital. Holders: L. G. Derey, 115, Fore Street, E.C., and D. A. E. Rees, 39, Threadneedle Street, E.C.

Southport Engineering Co. Ltd.—Mortgage dated October 16th, 1920, to secure £3,666, charged on 1, King Street, and 14-30, Market Street, Southport. Holders: F. Rowland, 15, St. James Street, Accrington, and others.

E. Forshaw & Son Ltd.—Issue on October 14th of £100 and October 21st, 1920, of £1.000 debentures, part of a series already registered.

E. Timmins & Sons Ltd.—Particulars of £10,000 debentures authorised August 31st, and covered by trust deed of September 28th, 1920, present issue £9,350; charged on certain freehold lands and premises at Runcorn and the company's undertaking and property, present and future, including uncalled capital. Trustees: London County Westminster and Parrs' Bank Ltd.

Monks & Crane Ltd.—Particulars of £1.000 debentures authorised August 20th, 1920, whole amount issued; charged on the company's undertaking and property, present and future, including uncalled and unpaid capital.

Lester & Browne (London) Ltd.—B. B. McCullum, F.C.A., of 5, Chancery Lane, W.C., as receiver, on October 14th, under powers contained in instrument dated September 20th, 1920.

Wilkins Wire Rope Co. Ltd.—Satisfaction in full on September 9th, 1920, of mortgage debenture dated February 9th, 1906, and February 27th, 1911, securing £4,000.

Corona Lamp Works Ltd.—Mortgage dated October 14th, 1920, to secure £1,200, charged on 1, Lysander Grove, Islington, N. Holders: Portman Chapel Temperance Benefit Building Society.

Williams Henry & Co. Ltd.—Charge on Abbey Garden Works, St. Margaret Street and Monastery Street, Dunfermline, plant, engines, etc., dated October 6th, 1920, to secure all moneys due or to become due from company to mortgagees. Holders: Poulton Bros. & Co., 39, Old Broad Street, E.C.

Baynes & Partners Ltd. Mortgage dated September 28th, 1920, to secure £10.000, charged on certain land and premises at Mitcham, Surrey, and company's undertaking and other assets, including uncalled capital. Holder: L. Jackson, Glenhaven, Gloucester Gate, Regent's Park, N.W.

British Metallurgic Co. (Birmingham) Ltd.—H. E. Clarke, of 8, Newhall Street, Birmingham, as receiver, on October 14th, 1920, under powers contained in mortage debenture dated July 21st and 22nd, 1919.

Patent Applications.

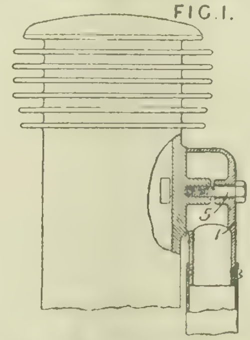
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

INTERNAL-COMBUSTION ENGINES.

144,494. W. J. GEORGE, 157, Great Charles Street, and L. BIRCUMSHAW, San Toy, Swanhurst Lane, Moseley, both in Birming-

FIG. I.



ham July 12, 1919. The exhaust pipe elbow 1 is clamped to a flat surface on the side of the cylinder by a central bolt 5 in order that the direction of the pipe may be varied.

COOLING-TOWERS, ETC.

132,445.—W. HOLEHOUSE, 21, Morley Street, Bradford, Yorkshire. Mar. 7th, 1919.—The grid-work of a cooling tower or like apparatus comprises inclined bearers F, secured to uprights E, and drip-bars G of square section notched into the bearers and arranged so that the liquid and the cooling-air meet the surfaces at an angle. The drip bars in one bearer are vertically over those in the bearer below, and may be secured by "keeper" bars G2, Fig. 4. The bearers may be pegged or tenoned to the uprights, and may slope in either direction. Where the bearers of adjacent bays are in alignment, the ends of the bearers are cut

FIG. 1.

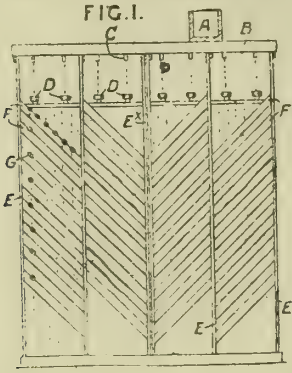


FIG. 3.

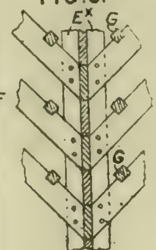
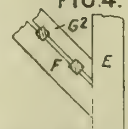


FIG. 4.



at angle to the length, as shown in Fig. 3. The uprights may be divided, as shown at E× in Fig. 1, to receive vertically-placed boards forming a partition to prevent a direct cross-current of air. The water is distributed from a main trough A by gutters B, overflow pipes C, and splash-plates D.

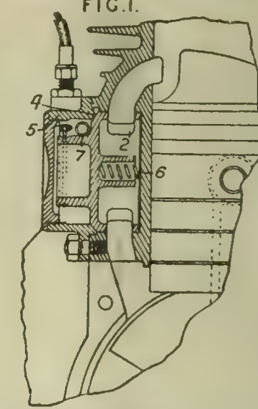
CONDENSING STEAM.

143,584.—D. B. MORISON, Hartlepool Engine Works, Hartlepool, Durham.—June 10th, 1916.—In steam-condensing plant operating in accordance with the method described in Specification 143,273, the steam-jet air-ejector is so located and of such capacity as to extract a comparatively large volume of the steam-air mixture from the zone within the main condenser where active condensation ceases. The arrangement of plant used is the same as that described in the above-mentioned specification.

INTERNAL-COMBUSTION ENGINES.

144,468.—C. ROBOTHAM, 7, Cannon Hill Road, Birmingham.—June 7, 1919.—In order to maintain maximum pressure in the crank case compression chamber for all speeds, and thus prevent loss of strokes at low speed, a throttle valve is fitted in the transfer passage between the crank case compression chamber and the firing chamber. A rotary valve cylinder 2 with apertures in

FIG. 1.



line with the passage is mounted for control by a Bowden wire against a spring 7 tending to shut it. A conical seating is formed on it to engage a cone 4 on a cover 5 and a spring 6 maintains the contact during induction of the charge.

The Imperial Railway Electric Power Co. of Japan.—A Bill has been introduced in the House of Representatives proposing the organisation of a semi-official electric power company, with the object of supplying power to the Imperial Railway, and, if there is any surplus, to other railways or tramways, and even for other undertakings, with power to carry on various subsidiary businesses with the sanction of the Government. The duration of the company is to be 100 years, and the capital 100,000,000 yen, of which 50,000,000 yen is to be supplied by the Government, partly in cash and partly in the shape of all the electric power installations belonging to the present Railway Department, and the land and other property connected therewith. The Bill also provides that none but the Government and other public bodies, Japanese subjects, and juridical persons organised under Japanese law, may become shareholders.

INDEX TO ADVERTISERS.

[When enquiring of Advertisers will readers kindly make a "special point" of mentioning The Industrial Engineer.*]*

— THE —

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CONTENTS.

EDITORIAL.

THE TWO-SHIFT SYSTEM.

A REPORT, which is interesting to employers and workers alike, has been made by the Home Office Committee which was appointed last August to consider whether or not it was desirable that the Factory and Workshop Acts should be so amended as to allow women and young persons to be employed on the system of two day-shifts. After carefully considering all the evidence, the following recommendations have been made by the Committee:—

1. The Secretary of State should be given power to make Orders allowing the employment of women and young persons of 16 years of age and over on a system of two day-shifts of not more than eight hours' average duration between the hours of 6 a.m. and 10 p.m. from Monday to Friday, and 6 a.m. and 2 p.m. on Saturday. These Orders should, we think, be granted for individual factories, or for a class or group of factories, subject to such conditions as the Secretary of State may consider necessary to safeguard the welfare and interests of the workers. The Orders should be expressed to be liable to withdrawal in the event of non-compliance with the conditions or of any abuse arising, but subject to this should be regarded as intended to be effective for the period hereinafter mentioned.

2. The power to make the Orders should be given for a limited period of five years in the first instance, and at the end of, say, four years, inquiry should be made into the whole question in the light of the additional experience gained.

The two-shift system will not become a permanent part of our industrial system without much canvassing of its merits and demerits. The evidence before the Committee convinced it that while the system even yet is largely experimental, it is worthy of a fair trial, and is valuable when there is a temporary shortage of plant. It appears to us to be infinitely better than having a day-shift and a night-shift, and it enables employers to make full use of costly machinery.

It was the opposition of organised labour that led to the formation of the Home Office Committee, and the chief objection appears to have been the belief that it would promote irregular habits, be an additional burden on the housewife, curtail opportunities for education, and have an adverse effect on health. It is worth while considering how many of these objections are well founded, and if any of them are the result of the deep conservatism of labour. On the question of health, the medical evidence heard by the Committee was not against the two-shift system, and it is interesting to note that the evidence of workers was so contradictory that, to use the Committee's words, "no general statement of the opinion held by the women could be arrived at." The objection with regard to education is not a serious one and may be easily overcome by special arrangements being made to suit the young people. One cannot understand the danger of irregular habits; it might be so if the hours were changing from day to day. The vital objection is perhaps with regard to the extra labour that devolves on the housewives making meals all day long. It may be remembered that in Lord Leverhulme's suggested six-hour day scheme, which was based on the two-shift system, it was proposed to provide meals on the factory premises to obviate this objection, and, indeed, with the growth of the works canteen, this objection dwindles considerably.

THE MANUFACTURING OF DOUBLE HELICAL GEARING.

By M. Coronel.

General Considerations.

There are three principal methods of manufacturing modern machine-cut double helical gearing. They are (1) the planing or shaping method, with or without generation; (2) the end milling process; (3) the hobbing process. The teeth of gear wheels should be generated, and not all the above named processes adapt themselves to this method. By generating a gear in the process of cutting is understood the process of making a cutter not shaped exactly the size of the space between two teeth, hav-

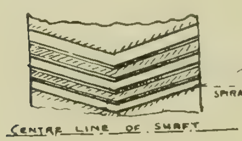

Fig 1.

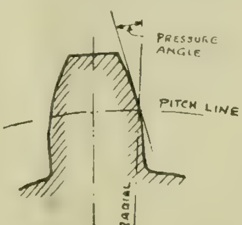

Fig. 2.

ing in addition to its ordinary shapings, milling or planing movement, a further motion similar to that of the gear wheel or pinion which will be required to work with the gear to be cut. From this it will be clear that the cutter for a generated gear must be smaller by the amount of such movement.

There are various points to be considered with gears as those here under consideration, viz., the spiral angle, the pitch and the face width. The spiral angle is the angle of inclination of the teeth

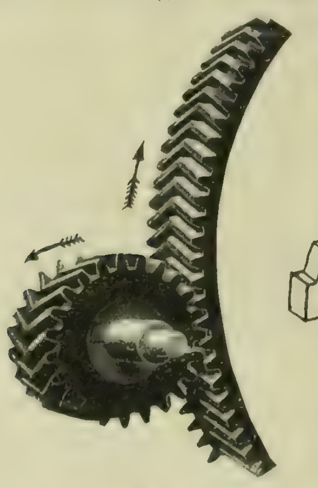

Fig. 3.

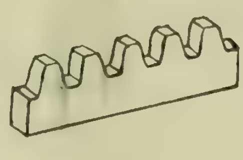

Fig. 4.

with the axis of the gear, see Fig. 1. The various angles used for the above mentioned methods are: "Sunderland" planing process, spiral angle 22 deg. – 30 min. End milling process, spiral angle 32 deg. 9 min. Hobbing process 25 deg. to 45 deg. The pressure angle is the angle between a tangent to the tooth side at the pitch line, and the radial at this point (see Fig. 2), and is usually for the gears under consideration 14½ deg., but angles of 14 deg., 15 deg., 20 deg., 22½ deg. are sometimes used. The face width on all double helical gears should be at least five times the circular pitch, and in the case of large marine turbine gears is often as much as 36 to 40 times the circular pitch. The pitch is largely dependent on the class of gearing and the work to be transmitted, but it is in no way in direct ratio to the power required. Marine turbine gears of very large powers transmit through pinions with pitches as small as ·4 in. circular pitch. First method: The planing method has several representatives, as the "Sunderland," "Gleason" and others. They produce either continuous, staggered or teeth with a small space between the two helics.

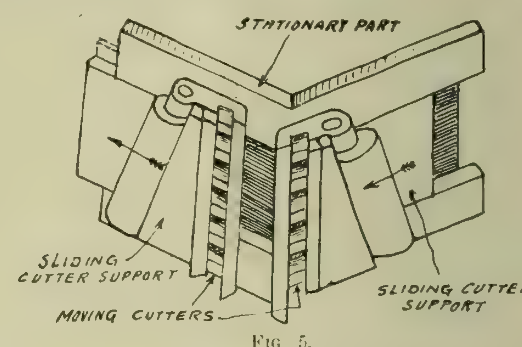

Fig. 5.

The Sunderland Method.

This method produces the continuous teeth with a sharp apex (see Fig. 3), the point where the two helics meet. The cutter used in this process is a flat plate, the shape of a rack about ½ in. to 1½ in. thick according to pitch. The teeth are, however, not straight as by the involute rack, but of a curvative between the straight line and the finished tooth of the gear, working with the gear to be cut (see Fig. 4). This cutter has three principal movements, (1) the movement of planing along the side of the tooth, there is a cutter for each half of the helics, each

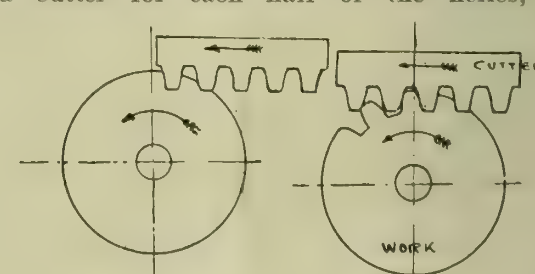

Fig. 6.

cutter moving in the direction of the spiral angle, both cutters moving in the same direction, viz.:—as one rack cutter descends planing one side of the helics, the other simultaneously withdraws on its return stroke, see Fig. 5., which illustrates the slide in which the two cutters move in the direction of the spiral angle. (2) After each cutting stroke the work rotates and the cutter moves downwards, forming together a rolling action as in actual working practice and shown in Fig. 6, the one of which shows the cutter just entering the other, having half entered and having finished one space. The third

movement is necessary in order to limit the length of the cutter rack, as otherwise this would have to be of greater length than the circumference of the blank. Consequently, when the cutter has moved as in Fig. 6 the distance of one pitch, the wheel blank is withdrawn automatically from engagement with the cutter, its rotating motion checked, and the cutter is then returned into its original starting position, a position earlier than shown in the first of Fig. 6.

The blank is then again moved towards the cutter whilst the rotary motion of the blank and the longitudinal one of the cutter is started simultaneously, the whole of these movements being automatic. At the end of each cycle of operations the blank has moved one tooth ahead of the cutter. Automatic and

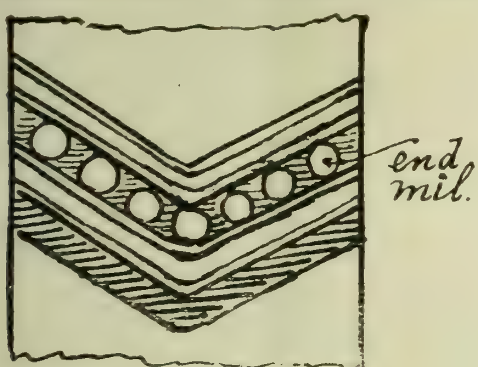

Fig. 7.

true generation of correct tooth form is the outcome of the above-described process. The blank is situated in front of the cutter on a horizontal spindle and the cutter fixed on a vertical plane. In this system the two cutters, each for one spiral are so arranged that they reciprocate towards each other, cutting right to the very apex of the extreme centre of the gear. With this system a central gap is not required, one cutter in fact removing the bur left by the other cutter on its previous down stroke. The actual driving contact takes place along the entire face width of the gear, which cannot be said with any other method of generation of continuous double helical teeth.

Fig. 8

The End Mill Process.

With this process a cutter is used, the form of an end milling cutter, having the shape of the space between the teeth. The cutter has a rotary motion and is mounted horizontally in front of the blank at right angles to the axis of shaft of the wheel, which latter is also mounted horizontally. The end milling process enables the tooth to be cut in one continuous piece from the solid material either as a double, treble of more helical gear, thereby ensuring great strength. It is, on the other hand, impossible to utilise the central or apex portions of the teeth for driving purposes as by the "Sunderland" method described, owing to the fact that the end mill when passing from one side to the other of the helics describes a sharp or nearly sharp corner on its inner path, but a radial contour on its outer path (see Fig. 7). The outer point of the tooth apex can be made sharp or slightly curved, but whatever shape the corresponding corner of the tooth on the inside has to be larger by the amount of the radius of the cutter. The end mills are not suitable for very small pitches, the operation is a lengthy and expensive one. The end mills used for the purpose take the shape as shown in Fig. 10.

The double or treble helics is either obtained by giving the cutter its rotary motion only and the wheel to be cut, the motion of the two helics, and after cutting one space, automatically shifts round the amount of one pitch and does the same operation again; or the cutter can be given, in addition to its rotary motion, the movement for producing the double helics, the wheel only shifting one pitch at the completion of each space cut. In the process a roughing cut is generally taken first, afterwards to be finished by a cutter the exact shape of the space. The helics angle is generally somewhere about

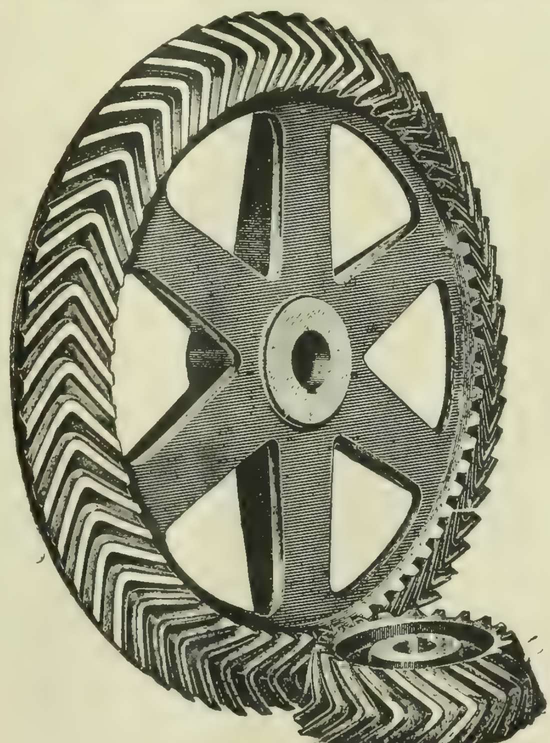

Fig. 9.

30 deg. or 32 deg., but there are gears made with one tool only, in one operation from the solid with a spiral angle of 45 deg. From these gears an efficiency is claimed as high as 98–98·7 per cent with gear ratios up to 20 : 1 for single reductions with a minimum of four teeth, and these shrouded (Fig. 14). A spiral angle of 52½ deg. is often chosen for double helical end milled bevel wheels, see Fig. 9.

The previously described method is not suitable for cutting bevel wheels; the method of end milling, however, can also be applied to bevels. The machines used for these latter gears are practially similar to those used for cutting double helical spur gears, the essential difference being that the two beds, the one for carrying the cutter and the one for the blank, are

so mounted as to be capable of being placed at any desired angle in relation to each other. One of the beds is made movable round a vertical axis. The teeth in such bevel wheels follow the contour of an archimedian spiral, and the wheels (see Fig. 10) so cut require only angular movements of the blank proportionate to the linear displacement of the cutter.

The Hobbing Method.

Contrary to the two previously-described processes, this method cannot produce a continuous double helical

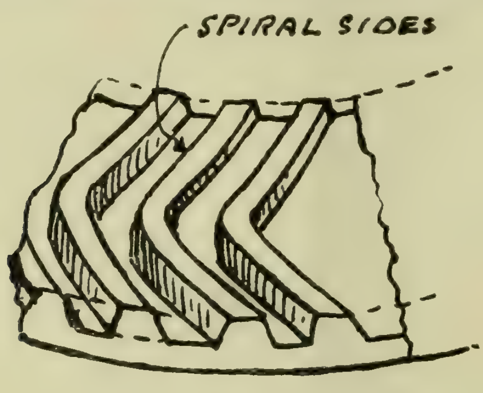

Fig. 10.

tooth, each side of the blank must be cut independently of the others, two hobs being necessary for the right and left hand spiral respectively. The two sides of the helical have to be separated by a gap usually 1 in. to $1\frac{1}{2}$ in. wide according to the diameter of hob being used. Fig. 11 and 12 show the hob in position at the beginning and the end of the cutter operation. But by staggering the teeth, making the teeth of the left hand spiral opposite the spaces of the right hand spiral, it is possible to do without a gap, but still the teeth are not continuous, see Fig. 13. In hobbing

Fig. 11.

Fig. 12.

double helical teeth the axis of the hob is generally mounted at right angles to the axis of the blank, as this position tends to minimise the width of the gap and consequently the total width of the gear.

The lead angle of the hob corresponds with the spiral angle of the blank, as can be seen from Figs. 11 and 12. It is, however, interesting to note that the root diameter of the wheel is cut with the outside diameter of the hob, but the spiral angle at the root of the wheel can never agree with the lead angle on the outside diameter of the hob, unless the hob be especially made to suit the exact number of teeth in the individual wheel cut. In this method the hob is essentially a worm having the required pitch. The worm hob is rotated round its axis, the blank moves as if working as a worm wheel and worm rotating continuously in the direction of the helics till the hob arrives at the gap, the wheel then sets back to its original position and shifts one pitch further. When the next tooth is cut, and so on, the second helics being cut in a similar manner with a cutter of

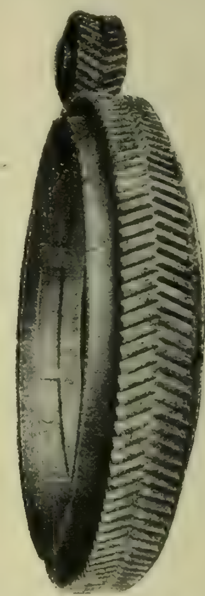

Fig. 13.

opposite hand spiral angle. The movement of the cutter is at the same time towards the apex of the teeth and returns after each cut to its original position.

Turbine gears, both for land and marine purposes, are almost exclusively made by this method, the wheel having its axis vertical, the cutter having its axis horizontal. Pinions, however, are often cut

Fig. 14.

with their axis horizontal, the cutter axis being vertical. The spiral angles of such gears are from 23 deg. to 30 deg. with circumf. pitches as small as 4 in., and seldom larger than $\frac{5}{8}$ in.; the consequence being that several teeth are always in mesh which transmit the load gradually and simultaneously, ensuring noiseless and smooth running at very high speeds up to 135 ft. per sec. at pitch line.

BRAKE LEVER DESIGN.

By V. M. S.

While the present article deals specifically with problems encountered in the design of brake levers and brake riggings for railway equipment, it nevertheless presents data and information which may be employed to advantage in designing brake levers intended for other purposes. Through some fault in design, brake levers often fail to meet requirements satisfactorily, and it is the purpose of this article to present data which has been found useful in correcting mistakes frequently made when designing these parts. Before attempting to solve any practical problems,

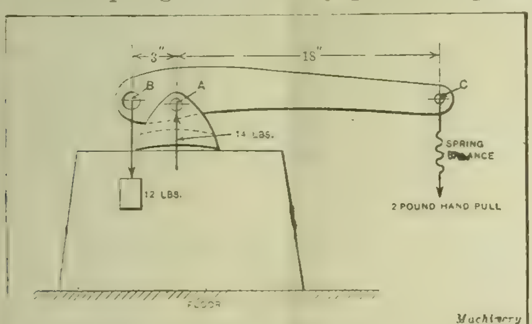

Fig. 1.—Example of Simple Brake Lever maintained in Equilibrium by known Forces.

it is, perhaps, well to consider the theories and important principles involved in lever design. First, let it be assumed that the lever shown in Fig. 1 is made to balance itself at A; now apply a weight of 12 lbs. at B, 3 in. from A. The pull of the spring balance at the point C—18 in. from A—is, of course, 2 lbs., and the reaction at A, 14 lbs. While it is a well-known fact that these conditions obtain with brake levers arranged as shown in Fig. 1, the all-important principle at back of it is not always followed when the levers are arranged as shown in Fig. 2. The reason for this may be that it is not thoroughly understood; therefore it is well to follow closely the simple

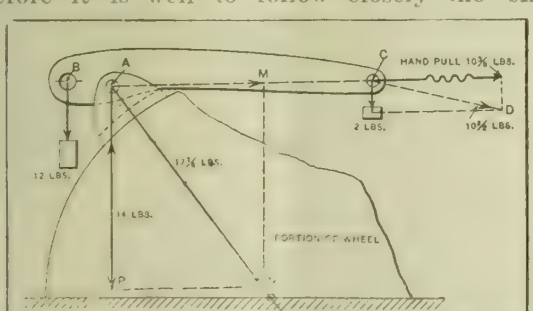

Fig. 2.—Example showing Effect of Direction of Brake-shoe Pressure on Brake Rigging Design.

experiment illustrated in Figs. 1 and 2, before attempting any further theoretical considerations. In reviewing the theoretical side of this problem it is advisable to define the principle involved in terms of the following rule.

Rule.—If a lever is in equilibrium, the moments of any two of the forces about the point of application of the third are equal and opposite.

Now, bearing in mind that the moment of a force about a point is the product of the force, and the perpendicular distance between the point and a line representing the direction in which the force acts, let the equation representing the moments about points A, B, and C of the lever shown in Fig. 3 be written as follows:—

$F \times a = R \times b =$ moments about point A
$F \times g = Q \times e =$ moments about point B
$Q \times f = R \times d =$ moments about point C.

Now, referring to Fig. 1, it will be seen that besides the well-known moments about point A, $12 \times 3 = 2 \times 18 = 36$, there are also two other identities to be

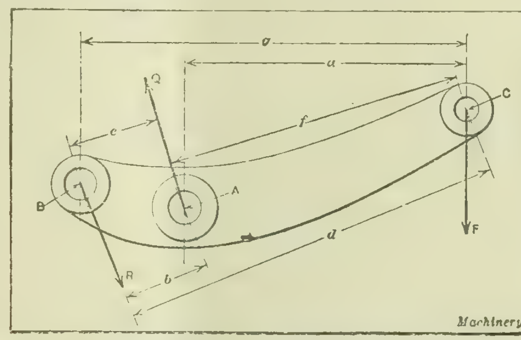

Fig. 3.—Diagram illustrating Analytical Method of expressing Principle of the Lever.

considered, namely, the moments about points B and C. These may be written as follows:—

$2 \times 21 = 14 \times 3 = 42$, moments about point B
$12 \times 21 = 14 \times 18 = 252$, moments about point C.

The preceding is the analytical method of expressing the principle of the lever, but there is also a graphical method which may be defined by the following rule.

Rule.—If a lever is in equilibrium and the forces acting on it are all in the same plane, the lines representing the direction in which the forces act will

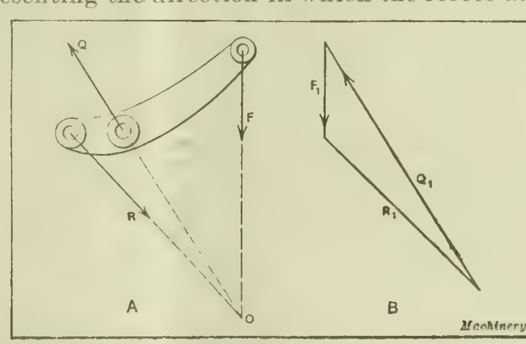

Fig. 4.—Diagram illustrating Graphic Method of expressing Principle of the Lever.

either meet at some point or they will be parallel with each other; these lines may represent both the magnitude of the forces; also, the forces maintaining equilibrium in a simple lever such as shown at A, Fig. 4, may be represented by the so-called triangle of forces.

The simplicity of this method is shown by referring to Fig. R and F in the illustration at A, represent the two forces, while Q represents the reaction at the fulcrum pin. The triangle of forces shown at B is constructed by first drawing F_1 to some scale

representing the magnitude and the direction of the force F; using this same scale, draw line R_1 representing force R. Now draw the line Q_1 connecting the ends of these two lines. The line Q_1 represents the magnitude and direction of the reaction Q. The preceding rules are simple and may be easily remembered, and are therefore to be preferred to the old-time rule which divides the levers into three distinct kinds or classes.

Bearing these essential rules in mind, we can now consider the problem illustrated by Fig. 2, which forms the main subject of the present investigation. In the arrangement shown, the 12-lb. and the 2-lb. weights are still required to keep the level horizontal and perfectly balanced; the effect on the wheel, however, obviously is not the same as on the level block shown in Fig 1. In order to prevent the lever and the shoe from sliding off the wheel, it is necessary to exert an additional pull at C. The spring balance will show a hand pull of approximately $10\frac{5}{8}$ lb. if the direction of pull is along the line AC, provided the surfaces of contact are sufficiently smooth. The pin C would, therefore, be subjected to a total load of $10\frac{1}{2}$ lb., which is the resultant of the hand pull and the 2-lb. weight; while the wheel itself would be subjected to a radial pressure in the direction indicated by line AN equal to $17\frac{1}{4}$ lb., or the resultant of the $10\frac{5}{8}$-lb. hand pull and the 14 lb. original pressure as given by the parallelogram of force MAPN. By applying the two rules of graphics, namely, the principles of the concurrence of three balancing forces and that of the triangle of forces, these resultants can be arrived at more readily. This is shown in Fig. 5, where the forces converge in the point O, and where the magnitude and direction of the unknown quantities may be determined by the sides of triangle MON.

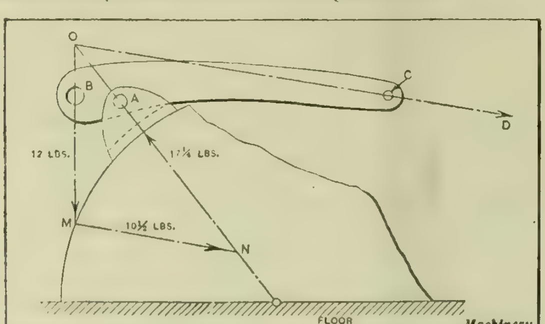

Fig. 5.—Diagram illustrating Graphical Method of solving Problem shown in Fig. 2.

In order to apply these rules properly, it is necessary to know the direction of the line AN representing the position of the shoe pressure. This is easily determined by an axiom which has been fully established in the study of mechanics, that is: *The mutual pressure between two bodies at rest acts along a common normal to their surfaces of contact.* Now for wheels and brake shoes this normal must necessarily pass through the centre of the wheel. Therefore when railroad specifications call for a certain braking power, it should be universally understood that the required force is to be applied to the drivers in a radial direction. The specifications could not mean anything else, as otherwise the so-called braking power might not have the desired retarding effect on the drivers, for by simply changing the direction or the location of the pull-rods, it would be possible to obtain a wide variation in the actual braking force. From this it will be seen that specifications for the brake shown in Fig. 2 should not refer to the original 14-lb. force, but should specify the $17\frac{1}{4}$-lb. radial pressure as indicated in Figs. 2 and 5. If care is not taken in this respect, skidding will result.

The actual driver-brake rigging, shown in Fig. 6, is materially the same as that given in Figs. 2 and 5, except that the effect of frictional force has been taken into consideration. Friction was purposely disregarded in the other problems in order to simplify the experiments. Now, referring to illustration L, Fig. 6, it will be noticed that, instead of the normal force W, we have the new force Q or the resultant of the braking power required and the assumed shoe friction. The pin C is carrying, in the direction of line OC, a load equal to MN, represented by the side of the triangle NOM which is paralleled to OC. This load is not found by combining *f* with the 2-lb. load as represented by R in the diagram at H, but resultant

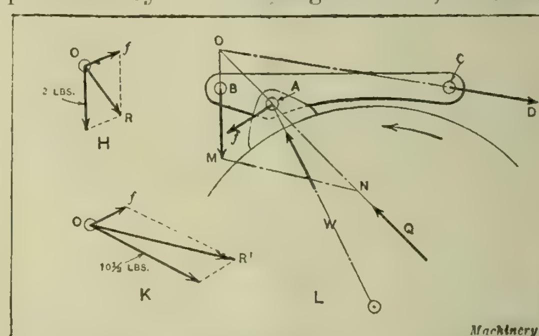

Fig. 5.—Diagram illustrating Method of determining Effect of Frictional Force.

R^1, represented in the diagram at K, gives the required value, being the resultant of the force *f* and the $10\frac{1}{2}$-lb. force. When it is realised that the loads at C as determined by these rules show values more than twice those obtained by the methods of calculation frequently though erroneously employed, the importance of exercising care in designing brake levers will be more fully appreciated. The difficulties experienced with brake levers designed without taking into consideration the factors just dealt with may be summed up as follows:—

(1) Skidding of drivers, flat tyres, loss of braking energy.

(2) Lack of a common standard shoe pressure between brakes designed by private companies and railroads, which prevents an intelligent comparison of their experiences and investigations.

(3) Hanger-lever top pins entirely too weak.

(4) The production of a second bending moment on all return hanger levers besides the usual bending moment of plain flat levers, due to the upward pull at C.

(5) Hanger-lever brackets often too weak at the root of the projecting arm.

(6) Inadequate fastenings between hanger-lever brackets and frame due to errors in calculating magnitude and direction of the force acting on pin C.—*Machinery.*

Dortmund Iron and Steel Works.—The profit realised during the past financial year by the Dortmund Iron and Steel Works amounted to 52 million marks, as compared with eight millions for the previous year. Reuter.

HEAT APPLIED TO ENGINEERING.

By Prof. W. W. Haldane Gee, B.Sc., M.Sc.Tech.

(*Continued from page 4, November 8th.*)

Measurement of Platinum Resistance.

Special types of Wheatstone bridges have been designed by Callendar and Griffiths for the accurate measurement of thermometer resistances. They are known as "self-testing" bridges, for the reason that the errors of the coils can be tested directly with the bridge itself. With the most elaborate type, resistances can be measured from 400 ohms downwards, with an accuracy of 0·00001 of an ohm. The coiled are made of manganin which are immersed in an oil bath fitted with a stirrer. For commercial work a much simpler arrangement is required, such as that shown in Fig. 17. The ratio coils are of equal value, and hence when the galvanometer indicates a balance the other arms of the bridge are also of equal resistance. Thus in the diagram we should then have:—

Resistance of platinum wire of the thermometer + its leads = resistance of bridge coils + adjusting rheostat + compensating leads + resistance of ice bobbin.

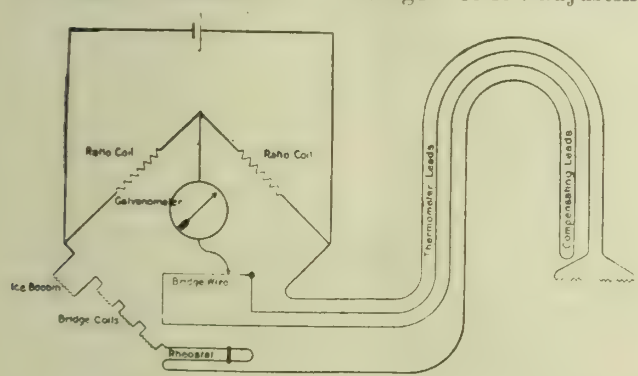

Fig. 17. Wheatstone Bridge Connections.

Care is taken to make the leads of the same resistance, and the ice bobbin has been adjusted so that it has the value of the platinum when the latter is at freezing point.

It will be understood that a scale of temperatures could be provided adjacent to the bridge wire so that the temperature could be directly read off without any calculation. This is the method adopted in the Whipple indicator (Fig. 18), which is arranged so that the four leads from the platinum thermometer P are connected to four terminals T. On depressing the contact key F and turning the handle H until a balance is obtained (as indicated by the galvanometer needle at B), then the temperature in degrees Centigrade or Fahrenheit can be directly read off on the scale at A. This scale is wound spirally on a drum, so that it is of considerable length. On turning the handle this drum both rotates and moves transversely; hence any part of the spiral scale can be brought under a fixed reading point. The length of the scale may be such that a range from 0° to 1,400° C. can be read off with an accuracy of a tenth of a degree. The bridge battery consists of two dry cells G. It is necessary to adjust the instrument by levelling screws until the circular spirit-level has its air bubble exactly centred, then the galvanometer needle should be free to swing between its two stops.

Types of Platinum Thermometers.

In deciding upon the type of thermometer to be used and its method of installation, the following details must be known: (1) The range of temperature, and whether Centigrade or Fahrenheit; (2) the length of stem that will be exposed to the temperature; (3) whether the thermometers are to be under a high pressure or immersed in molten materials; (4) when used in a furnace the thickness of its wall is required; (5) the distance that the indicator will be from the thermometer head; (6) the degree of accuracy required; (7) if it is necessary to protect the indicator from vibration; and (8) whether one indicator is to be used for a number of thermometers.

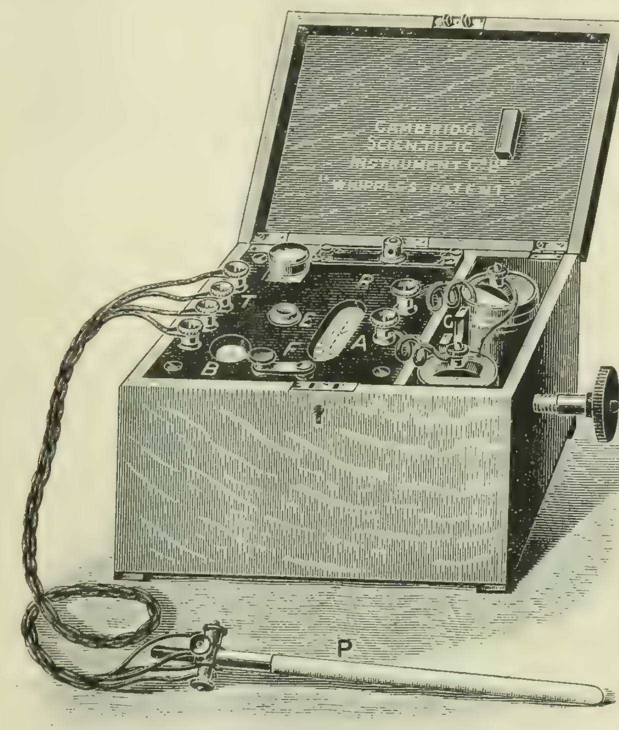

Fig. 18. – Whipple Indicator.

The last requirement is made by providing each thermometer with its own ice bobbin and also arranging that each has the same fundamental interval. The use of a multiple switch will enable any one of the thermometers (along with its own ice bobbin) to be connected at will with the indicator.

If temperatures only up to 100° C. are to be measured, the platinum resistance may be enclosed within a brass case and copper leads used, but for temperatures up to 500° C. a steel case may be advisable; for still higher temperatures, such as 1,200° C., a porcelain tube and platinum leads will be required. The head may be of hardwood, brass, or cast-iron, according to the position in which it is placed, and the temperature to which it may be subjected. Up to 700° C. it will be advisable to protect the porcelain tubes with steel casing. The thermometer tubes are made of lengths from about 12 in. to 60 in. length, according to the nature of the service required. For laboratory and

research work for temperatures up to, say, 300° C., Jena glass tubes can be used to enclose the thermometer, these tubes being about 30–40 cm. long and with a diameter of 12 mm., but tubes of about half this diameter are convenient when the temperature of a small amount of material has to be determined.

Quartz Glass Resistance Thermometers.

Experiments made in the laboratories of the German firm, W. C. Heraeus, have lead to the design of a platinum thermometer, especially intended for measurements up to 900° C. The platinum wire is coiled on a small rod of quartz glass, which is placed within a thin tube of quartz glass, and the rod is then fused within the tube so that platinum wire is firmly embedded and close to the surface of the enclosing tube. The leads are made of silver (for 400° C. limit) or gold, and are insulated from each other by capillary quartz glass tubes. It is claimed that thermometers so made respond very readily to a change of temperature, and which may be very abrupt without causing fracture of the thermometer. For laboratory work they may be made with a diameter as small as 3 mm. These thermometers should, whenever possible, be used without a protecting tube, but if external protection is advisable, they may be mounted within a metal tube.

(To be continued.)

RECENT ADVANCES IN UTILISATION OF WATER POWER.

By Eric M. Bergstrom, of London.

Associate Member of the Institution of Mechanical Engineers.

(Continued from page 23, November 22.)

A number of different designs of this method of regulation are now employed, but in each case the principle of operation can be traced to one of the three systems diagrammatically shown in Fig. 32. In each case the servo-motor of the oil pressure governor operates the deflector and spear simultaneously when opening, but by sudden closing of the governor the deflector will, in the first instance, cut into the jet and divert the water from the wheel until the spear by slowly overcoming the dashpot resistance, regulates the water-supply corresponding to the load, when the deflector will be brought back into a position just tangential to the reduced jet. The free movement of the deflector, independent of the spear in the closing direction, is in each case permitted by the "lost motion" existing in the mechanical connection between the deflector and spear.

In "A" the spear-rod is provided with a slot in which the pin of the lever connecting to the governor-shaft can slide. The opening and closing position of the deflector is shown, the latter in dotted lines, and by the pressure of the springs against the retarding action of the oil dashpot, the spear will slowly move forward until the slot has regained contact with the sliding pin.

In "B" the operation is identical with "A," although the lost motion between the deflector and spear is obtained through a displacement of the lever system relative to the fixed point *a*. In the closing direction the lever *b c* will follow the deflector movement with *b* as a fulcrum and take up the position as indicated in dotted lines on the diagram. The spring is now free to expand and exerts the necessary pressure to close the spear until the lever *b c* has regained contact with *a*, corresponding to the position *b c* in the diagram. In each of these two methods described, it will be observed that, firstly, the governor, irrespective of whether the load is thrown off gradually or instantaneously, always operates directly on the deflector, the spear meanwhile remaining stationary; secondly, that the governor brings the deflector out of the jet after each governing operation.

In diagram "C" a dashpot has been interposed between the governor servo-motor and deflector lever. By sudden discharge of load points *a* and *b* practically will move the distance, consequently the deflector will cut into the jet, and at the same time lever *a d* is moved away from the stop *g*. The spring, however, is strong enough to overcome the dashpot resistance and slowly brings the spear into position, at the same time lifting the deflector into a position

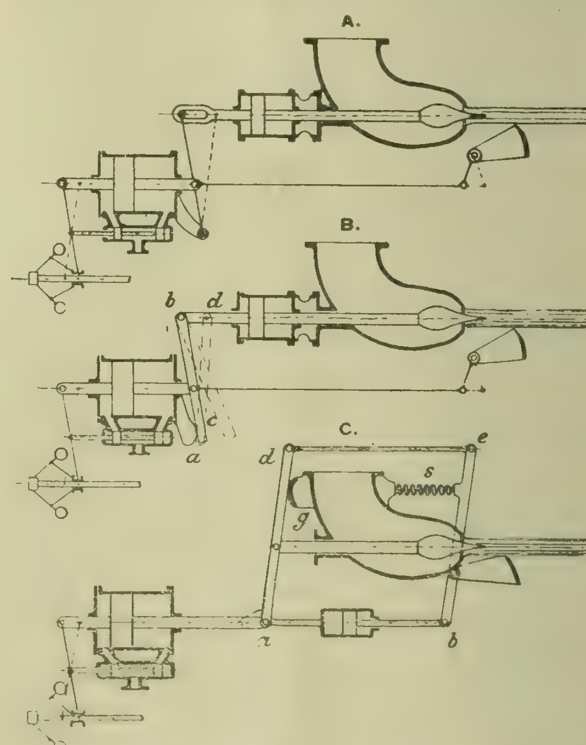

Fig. 29.—Regulation of Pelton Wheels.

tangential to the new jet. If, on the other hand, the load is only gradually discharged, the point *b* would remain stationary, and the governor would operate directly on the needle, the deflector being simultaneously moved forward through the lever *d e* to maintain its tangential position corresponding to the reduced jet. This latter design differs from the two foregoing in respect of operation when small and gradual load-changes occur, inasmuch as, in that case, the governor would operate the needle directly the deflector remains inactive, with which system, it is claimed, more steady speed-regulation for small loads changes is obtained. Pipe-lines in connection with water-power installations are classified as low, medium, and high pressure pipe-lines.

Low-Pressure Pipe-Lines.

The material used in the construction of low-pressure pipe-lines is either concrete, riveted steel, or wood. The concrete pipes are generally built *in situ*, in monolithic concrete, with various systems relating to the form of reinforcement. Owing the liability to leakage and sweating, it is not as a rule used under pressure, being employed in the upper portion of a pipe-line where the gradient is small, and the hydraulic gradient varying from zero to about 10 feet. Under these conditions, the concrete pipe-line has certain points of merit as regards initial cost and durability, and has an undoubted field of usefulness. On the other hand, the lack of flexibility and high coefficient of expansion, renders it necessary to make provision to prevent cracks due to uneven settlement where the soil is of a loose nature, and also suitable expansion joints which is often a difficult matter. In certain places, however, the concrete pipes have been made as a pressure line, when special form of reinforcement and treatment to exclude leakage has been adopted.

Wood stave pipes are utilised to a great extent for pressures up to about 175 feet both in America and Canada where suitable wood, best quality cedar fir, is to be found in abundance. For use in connection

FIGS. 30 AND 31.—Types of Water Gas Welds.

with water-power developments the pipe is made "continuous," the rough lumber being made into staves of correct shape and angles, and joined together on site by means of wooden or metal tongues and breaking joints between adjacent staves, so as to form a continuous length. The finished pipe is wound round with iron hoops and secured by adjustable clamps of malleable iron, through which the threaded ends of the rings pass and are tightened by means of washers and nuts. One of the chief characteristics of the wooden stave pipe-line is its durability and low cost together with a low coefficient of friction, and is, therefore, of particular advantage for the construction of the upper portion of pipe-lines where suitable wood can be procured.

Steel Pipes.

The two types of steel pipes, riveted or welded, are used in connection with hydro-electric plants, the former for low and medium pressures, and the latter exclusively for high pressure plants. For long pipe-lines, under low heads, the riveted pipe has been superseded either by concrete or wood, as for large diameter, the riveted pipe must be made sufficiently thick to retain its circular shape, and, in addition, take all the bending stresses caused by the weight of the water to allow as great a distance as possible between the supports, and consequently the cost is often prohibitive as compared with a conduit made of either of the first-mentioned materials. For instance, a 12-ft. steel pipe-line requires at least $\frac{1}{2}$ in. plate thickness to fulfil these conditions, whereas, as far as the hydrostatic pressure is concerned, $\frac{1}{4}$ in. would be ample.

Recent designs of large riveted steel mains under low heads have therefore aimed at a construction which would permit of a minimum plate thickness, and a maximum distance between the supports. For this purpose, the pipe is stiffened by means of angle irons, designed to take up the bending moments, and the shell of the pipe itself is correspondingly reduced in thickness.

The welded steel pipe-lines signify the most important developments in recent years as a result of the progressive utilisation of high heads, which

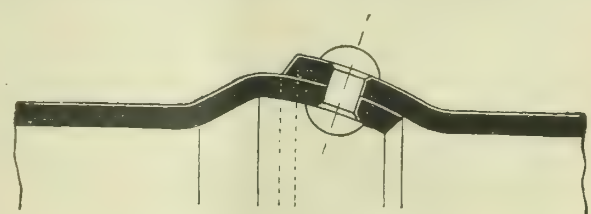

FIG. 35.—Bump Joint, Single Riveted.

necessitated a closer study of the pipe-line construction than had hitherto been the case. Moreover, the successful harnessing of falls of 1,000 feet or more could only be accomplished by using pipe-lines where the construction would offer the necessary safeguards and reliability of design as required, as a failure under these conditions would have the most disastrous results. Welded pipe-lines are exclusively used for high-pressure installations on account of their superior strength and absence of rivets to obstruct the flow water and consequently reduced friction losses.

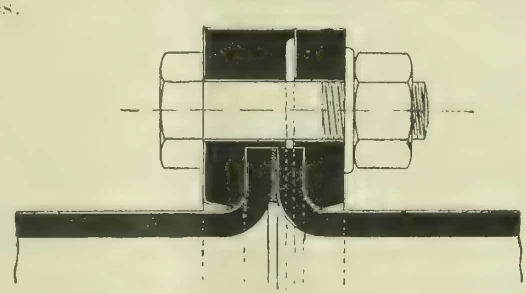

FIG. 33.—Flange Joint.

The welded pipes are made by the water-gas process, the plates being bent to shape and the overlapping edges, Fig. 33, heated by means of water-gas welded together under high speed mechanically-driven hammers, which method produces a weld of a strength of approximately 95–97 per cent of the strength of the full plate. After welding, the pipes are annealed to remove all internal stresses. The foregoing process of welding is only suitable for material up to about $1\frac{1}{4}$ in. thick, as, above this thickness, the heat would not penetrate sufficiently to produce uniform welding heat. For larger plate thickness, the "wedge-welding" method is resorted to, Fig. 34, the edges being brought together and a separate bar inserted forming the weld. With this method, pipes up to a thickness of $1\frac{3}{4}$ in. can be satisfactorily

welded. The material used in welded pipe lines is best Siemens Martin steel, with a tensile strength of average 28 tons per square inch and an elongation of 20–25 per cent in 8-in. test-bar.

On account of the pressure-rises whch the pipeline may be subjected to, the plate thicknesses are calculated with a factor of safety of 4–5 : 1, based on a strength of the weld equal to 100 per cent. The individual pipes are made in lengths of an average of 18 to 20 feet and using riveted joints for medium pressure and flange or expansion joints for high pressures, Figs. 35–37 representing the most common type of the three mentioned joints. In the riveted, or so-called "bump" joint, the pipe-ends have been swelled so that the rivet heads do not obstruct the free area of the pipe.

The flange-joint, Fig. 36, represents the most usual type adapted for large pipes, both ends of the pipe being turned up with loose cast-steel flange rings and rubber insertion joints. In pipe-lines

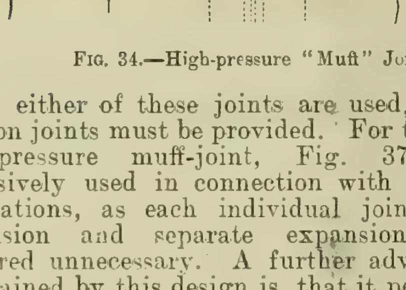

Fig. 34.—High-pressure "Muft" Joint.

where either of these joints are used, separate expansion joints must be provided. For this reason the high-pressure muff-joint, Fig. 37, has been extensively used in connection with turbine pipe-instalations, as each individual joint permits of expansion and separate expansion pieces are rendered unnecessary. A further advantage which is obtained by this design is, that it permits repacking the joint without displacing the pipe, in addition to greater facility in erection. Wthout exception, turbine pipe-lines are laid above ground to enable frequent inspection, each individual pipe being supported on a concrete support and heavy anchorages provided at all points where the pipe-line changes direction. In many cases, sufficient attention has not been given to this latter requirement, but the present high-presure work demands careful consideration to this point, in fact, every detail of the pipe-line has to be considered in the light of the very heavy duty imposed under the high falls now employed.

(*To be continued.*)

RECEIVERSHIPS, (APPOINTMENTS, OR RELEASE).

F. M. Proctor & Co. (1916) Ltd.—J. W. Shepherd, of 78, King Street, Manchester, as receiver and manager from Oct. 19th, 1920, pursuant to Order of Court.

Tri-ed Engineering and Motor Co. Ltd.—J. W. Phillips, of 599, High Road, Tottenham, as receiver and manager on Sept. 10th, under powers contained in trust deed dated June 11th, 1920.

Mensuration is not an "easy" subject, but many problems in the workshop can be solved if correct formulæ are known. For this reason the section on shop mensuration in *Calvert's Almanack*, which is clearly expressed, will no doubt be frequently referred to by workmen and others. The same may be said of the section on Horse Power, which gives definitions as well as data.

THE MEN WHO RETURNED: NEW BUSINESS TRAINING SCHEME.

From a Correspondent.

Dr. Macnamara, who, as Minister of Labour, is especially concerned for the welfare of these men, has seized upon the reawakening of national interest in the fighting man just now as an opportune time to bring forward a scheme for the business training of ex-officers and men of similar educational qualifications who served during the war, whether at home or abroad. His call is again to the employers, and he trusts that they will respond to it gladly.

At the present moment there are on the register of the Appointments Department nearly 11,000 officers and men for whom employment cannot be found. Dr. Macnamara believes that many of them could be absorbed in permanent employment at an economic wage if they were given opportunities for a year's training, and this view is shared by employers in various trades, who have already expressed their willingness to take men of this type for such a purpose.

The training to be provided will be restricted to courses with commercial and industrial—not professional—firms in the United Kingdom, and will be designed to fit the trainees for business appointments. The creation of skilled workmen is not contemplated for one moment. Employers are asked to give each man one year in which to qualify for employment, and also to give an honourable undertaking that at the end of that period they will take him into their service for at least 12 months, and pay him not less than £4 per week. During his year of training the man will receive a maintenance grant from the Government, with allowances, if he is married, for his wife and children.

As regards the men, the question of age does not affect their eligibility, but the following will not come within the scope of the scheme: (1) Those who have received practical or theoretical training under any Government scheme except as treatment training for war disability; (2) those who have secured suitable employment and discontinued it through their own fault, or wish; (3) those who have a pre-war occupation to which they can return, unless such occupations have been clearly unsatisfactory or merely of a temporary or very junior nature. (This does not include men prevented from so returning by war disability.) The unconditional and final date for receiving applications is April 30th, 1921. No premiums will be paid under this scheme.

Machinery is being set up by which is will be possible for firms who are willing to take men into their service to be supplied in 10 days, and in every case they will be given an opportunity of choosing from selected men, who will be submitted to them by the Appointments Department.

The scheme appears to be deserving of the careful and sympathetic consideration of every employer, however large or small his business may be. Full particulars of the procedure, etc., are available at the offices of the Appointments Department, which, in this directorate (covering the North-West of England and the Isle of Man), are as follows:—Manchester, 4, Cathedral Gates; Liverpool, Cooper's Buildings, Church Street; Carlisle, Clydesdale Bank Chambers, Bank Street.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 104 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 1 4	0 18 2 8	1 7 3 12	1 17 0 16	2 6 1 20	2 15 2 24	3 5 0 0	3 14 1 4	4 3 2 8	0
1	0 3 20	10 0 24	0 19 2 0	1 8 3 4	1 18 0 8	2 7 1 12	2 16 2 16	3 5 3 20	3 15 0 24	4 4 2 0	1
2	1 3 12	11 0 16	1 0 1 20	1 9 2 24	1 19 0 0	2 8 1 4	2 17 2 8	3 6 3 12	3 16 0 16	4 5 1 20	2
3	2 3 4	12 0 8	1 1 1 12	1 10 2 16	1 19 3 20	2 9 0 24	2 18 2 0	3 7 3 4	3 17 0 8	4 6 1 12	3
4	3 2 24	13 0 0	1 2 1 4	1 11 2 8	2 0 3 12	2 10 0 16	2 19 1 20	3 8 2 24	3 18 0 0	4 7 1 4	4
5	4 2 16	13 3 20	1 3 0 24	1 12 2 0	2 1 3 4	2 11 0 8	3 0 1 12	3 9 2 16	3 18 3 20	4 8 0 24	5
6	5 2 8	14 3 12	1 4 0 16	1 13 1 20	2 2 2 24	2 12 0 0	3 1 1 4	3 10 2 8	3 19 3 12	4 9 0 16	6
7	6 2 0	15 3 4	1 5 0 9	1 14 1 12	2 3 2 16	2 12 3 20	3 2 0 24	3 11 2 0	4 0 3 4	4 10 0 8	7
8	7 1 20	16 2 24	1 6 0 0	1 15 1 4	2 4 2 8	2 13 3 12	3 3 0 16	3 12 1 20	4 1 2 24	4 11 0 0	8
9	8 1 12	17 2 16	1 6 3 20	1 16 0 24	2 5 2 0	2 14 3 4	3 4 0 8	3 13 1 12	4 2 2 16	4 11 3 20	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·7	17·4	26·1	1 6·8	1 15·5	1 24·2	2 4·9	2 13·6	2 22·3	3 5	3 11·7	3 20	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 104 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 12 3 12	9 5 2 24	13 18 2 8	18 11 1 20	23 4 1 4	27 17 0 16	32 10 0 0	37 2 3 12	41 15 2 24	0
10	0 9 1 4	5 2 0 16	9 15 0 0	14 7 3 12	19 0 2 24	23 13 2 8	28 6 1 20	32 19 1 4	37 12 0 16	42 5 0 0	10
20	0 18 2 8	5 11 1 20	10 4 1 4	14 17 0 16	19 10 0 0	24 2 3 12	28 15 2 24	33 8 2 8	38 1 1 20	42 14 1 4	20
30	1 7 3 12	6 0 2 24	10 13 2 8	15 6 1 20	19 19 1 4	24 12 0 16	29 5 0 0	33 17 3 12	38 10 2 24	43 3 2 8	30
40	1 17 0 16	6 10 0 0	11 2 3 12	15 15 2 24	20 8 2 8	25 1 1 20	29 14 1 4	34 7 0 16	39 0 0 0	43 12 3 12	40
50	2 6 1 20	6 19 1 4	11 12 0 16	16 5 0 0	20 17 3 12	25 10 2 24	30 3 2 8	34 16 1 20	39 9 1 4	44 2 0 16	50
60	2 15 2 24	7 8 2 8	12 1 1 20	16 14 1 4	21 7 0 16	26 0 0 0	30 12 3 12	35 5 2 24	39 18 2 8	44 11 1 20	60
70	3 5 0 0	7 17 3 12	12 10 2 24	17 3 2 8	21 16 1 20	26 9 1 4	31 2 0 16	35 15 0 0	40 7 3 12	45 0 2 24	70
80	3 14 1 4	8 7 0 16	13 0 0 0	17 12 3 12	22 5 2 24	26 18 2 8	31 11 1 20	36 4 1 4	40 17 0 16	45 10 0 0	80
90	4 3 2 8	8 16 1 20	13 9 1 4	18 2 0 16	22 15 0 0	27 7 3 12	32 0 2 24	36 13 2 8	41 6 1 20	45 19 1 4	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	Weight.
	46 8 2 8	92 17 0 16	139 5 2 24	185 14 1 4	232 2 3 12	278 11 1 20	325 0 0 0	371 8 2 8	417 17 0 16	464 5 2 24	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 105 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs	Ft
0	..	9 1 14	0 18 3 0	1 8 0 14	1 17 2 0	2 6 3 14	2 16 1 0	3 5 2 14	3 15 0 0	4 4 1 14	0
1	0 3 21	10 1 7	0 19 2 21	1 9 0 7	1 18 1 21	2 7 3 7	2 17 0 21	3 6 2 7	3 15 3 21	4 5 1 7	1
2	1 3 14	11 1 0	1 0 2 14	1 10 0 0	1 19 1 14	2 8 3 0	2 18 0 14	3 7 2 0	3 16 3 14	4 6 1 0	2
3	2 3 7	12 0 21	1 1 2 7	1 10 3 21	2 0 1 7	2 9 2 21	2 19 0 7	3 8 1 21	3 17 3 7	4 7 0 21	3
4	3 3 0	13 0 14	1 2 2 0	1 11 3 14	2 1 1 0	2 10 2 14	3 0 0 0	3 9 1 14	3 18 3 0	4 8 0 14	4
5	4 2 21	14 0 7	1 3 1 21	1 12 3 7	2 2 0 21	2 11 2 7	3 0 3 21	3 10 1 7	3 19 2 21	4 9 0 7	5
6	5 2 14	15 0 0	1 4 1 14	1 13 3 0	2 3 0 14	2 12 2 0	3 1 3 14	3 11 1 0	4 0 2 14	4 10 0 0	6
7	6 2 7	15 3 21	1 5 1 7	1 14 2 21	2 4 0 7	2 13 1 21	3 2 3 7	3 12 0 21	4 1 2 7	4 10 3 21	7
8	7 2 0	16 3 14	1 6 1 0	1 15 2 14	2 5 0 0	2 14 1 14	3 3 3 0	3 13 0 14	4 2 2 0	4 11 3 14	8
9	8 1 21	17 3 7	1 7 0 21	1 16 2 7	2 5 3 21	2 15 1 7	3 4 2 21	3 14 0 17	4 3 1 21	4 12 3 7	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·75	17·5	26·25	1 7	1 15·75	1 24·5	2 5·25	2 14	2 22·75	3 3·5	3 12·25	3 21	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 105 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	4 13 3 0	9 7 2 0	14 1 1 0	18 15 0 0	23 8 3 0	28 2 2 0	32 16 1 0	37 10 0 0	42 3 3 0	0
10	0 9 1 14	5 3 0 14	9 16 3 14	14 10 2 14	19 4 1 14	23 18 0 14	28 11 3 14	33 5 2 14	37 19 1 14	42 13 0 14	10
20	0 18 3 0	5 12 2 0	10 6 1 0	15 0 0 0	19 13 3 0	24 7 2 0	29 1 1 0	33 15 0 0	38 8 3 0	43 2 2 0	20
30	1 8 0 14	6 1 3 14	10 15 2 14	15 9 1 14	20 3 0 14	24 16 3 14	29 10 2 14	34 4 1 14	38 18 0 14	43 11 3 14	30
40	1 17 2 0	6 11 1 0	11 5 0 0	15 18 3 0	20 12 2 0	25 6 1 0	30 0 0 0	34 13 3 0	39 7 2 0	44 1 1 0	40
50	2 6 3 14	7 0 2 14	11 14 1 14	16 8 0 14	21 1 3 14	25 15 2 14	30 9 1 14	35 3 0 14	39 16 3 14	44 10 2 14	50
60	2 16 1 0	7 10 0 0	12 3 3 0	16 17 2 0	21 11 1 0	26 5 0 0	30 18 3 0	35 12 2 0	40 6 1 0	45 0 0 0	60
70	3 5 2 14	7 19 1 14	12 13 0 14	17 6 3 14	22 0 2 14	26 14 1 14	31 8 0 14	36 1 3 14	40 15 2 14	45 9 1 14	70
80	3 15 0 0	8 8 3 0	13 2 2 0	17 16 1 0	22 10 0 0	27 3 3 0	31 17 2 0	36 11 1 0	41 5 0 0	45 18 3 0	80
90	4 4 1 14	8 18 0 14	13 11 3 14	18 5 2 14	22 19 1 14	27 13 0 14	32 6 3 14	37 0 2 14	41 14 1 14	46 8 0 14	90
Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	46 17 2 0	93 15 0 0	140 12 2 0	187 10 0 0	234 7 2 0	281 5 0 0	328 2 2 0	376 0 0 0	421 17 2 0	468 15 0 0	

Compiled and Arranged by T. E. Woodhouse.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

THE PRESENT POSITION OF THE MARINE DIESEL ENGINE.*

By James Richardson, B.Sc.

Recent experience with the most modern and economical steam installations applicable to merchantmen of average speed—the steam turbine and double-reduction gearing—has demonstrated clearly that the step from single to double reduction is not one of mere multiplication. New factors have been introduced and different values must be given to the various forces in operation. The large number of factors entering into this question is sufficient alone to suggest its nature. The most important of these are lubrication, alignment of shafts, coincidence of helical angles, material and design of inter-meshing teeth, pressure and rubbing velocity between teeth, torsional vibrations, all of which play their part. The present position, however, is such as to give to the Diesel engine a greater prominence than it might otherwise have achieved, in spite of the somewhat retrograde step from purely rotary to reciprocating motion.

Experience during the war with submarines showed the four-cycle engine in favourable light. Where reduction of weight, compactness, maximum power per unit volume of ship occupied by internal-combustion machinery were the chief considerations, the four-cycle principle was found fully to meet the requirements. In Germany the two-cycle engine was most favoured for marine work prior to 1914, but for submarine propulsion during the war this system was gradually dropped. Ultimately, by far the larger number of German submarines and all having the highest power per unit had four-cycle engines. In our own navy the four-cycle principle was almost exclusively adhered to.

The most important of the problems of design are common to both two and four-cycle engines, and the first concerns the injection of the fuel into the working cylinder. The exact quantity of fuel at a pressure sufficient to ensure injection must be measured out by the pump and spread in some 30 deg. of revolution as widely as possible into the combustion space, in a sufficiently finely-divided state to ensure rapid ignition and satisfactory combustion. Chiefly in this direction of improving distribution of the fuel in the combustion chamber can increased economy be sought.

There are two alternative methods of spraying; one by means of compressed air, the other by injecting the fuel at a high pressure known as the solid injection system. The utilisation of compressed air is most general. So far as marine installations are concerned, the principal advantage of the solid injection method, where compressed air is not used to assist injection, and is only required for supplying manœuvring power, is that the compressors are not a part of the main propelling engine and do not require to run continuously at sea. Moreover, the compressing plant, where solid injection is adopted, can be reduced by from 40 to 50 per cent in capacity.

Reliability with air compressors delivering at 850 lb. to 1,000 lb. per square inch has now reached a high level, the leading factors towards this end being generally appreciated, and air-compressor problems rated at their full value. Multi-staging is essential, and compression to 1,000 lb. per square inch should be carried out in not less than three stages, so proportioned that no undue ratio of compression and consequent temperature can occur in any stage. Particularly should the first or low-pressure compression be minimised. Such rises of temperature as are inevitable with compression should be reduced by efficient cooling of the air during compression and by the installation of inter-coolers and after-coolers to reduce to atmospheric whatever temperature remains after compression. Removal of moisture from the air should be facilitated. Every effort in design should be made to ensure that the compressor valves and springs can be easily removed and replaced.

It is not to be inferred in any way that finality has been reached in compressor design or in methods of injection. In regard to the former a better means for removing oil and moisture from the air is required, and in respect of injection of fuel into the main cylinder a suitable valve should be produced which, whilst requiring compressed-air spray for full power and maximum efficiency, can still operate satisfactorily at reduced power without the medium or assistance of compressed air.

The other fundamental of injection, the measuring of the oil fuel, involves the most delicate apparatus associated with the Diesel oil engine—the fuel-injection pumps and controlling gear. The system of having one pump per cylinder is now almost universal for marine work (excepting where solid injection is used), and only in this way can the maximum security against a large percentage of overcharge and overload in one or more of the cylinders be obtained. These individual pumps, therefore, become of relatively small size. Even with separate pumps, continual care and intelligent supervision must be exercised to ensure that the deliveries from the pumps are maintained equal, lest one or more cylinders should be overloaded to counteract the effect of diminished deliveries from defectively working pumps. Means are now generally provided whereby any pump can be cut out and overhauled whilst the remainder are in operation.

The Diesel engine remains a heavy and expensive prime mover in comparison with its steam rivals. Even with the progress made in design within the last six years, it can definitely be stated that there has been generally an increase in the weight and the space occupied by the slow-speed Diesel engine per horse power developed continuously. The factors opposed to a reduction of these disabilities and rendering difficult the path towards the higher powers now desired are the temperature gradient through the metal surrounding the combustion chamber and the fact that the major portion of the material of the engine is only utilised for a small fraction of the running time. The former refers particularly to the two-cycle, and the latter to the four-cycle engine, where three-quarters of the running time is idle, so far as power output is concerned. Moreover, of the one-power stroke per two revolutions, only one-half of this stroke or 12·5 per cent of the cycle stresses the

* Paper read before the Scottish Institution of Engineers and Shipbuilders in Scotland.

parts of the engine comparably with their strength and scantlings.

The unique economies possible by the adoption of the principle of internal-combustion are only gained at the expense of foregoing all the many advantages derived from using the most flexible known power-conveying medium, steam.

To appreciate the type of stressing to which the main parts of a Diesel engine are subject, comparison may be made with a steam engine of normal design and of equal power output. The maximum normal load with the oil engine is more than five times as great, and, furthermore, the rate of application of this main load is increased ten times.* With internal-combustion the normal stresses are liable to sudden increases calling for a larger factor of safety, and design questions relating to the main parts of the engine must be considered strictly in this light.

For a better utilisation of materials than is achieved with the four-cycle engine, the two-cycle single-acting, the four-cycle double-acting, the opposed pistons construction, the two-cycle double-acting principles, or the combined effect of oil and steam, as with the "still" engine, are put forward. However attractive may be the mechanical arrangements so facilitated, the Diesel oil engine is a complicated machine highly loaded and stressed by high-pressure combustion within the cylinder, and short cuts to achieve reduction in space, weight, and cost will only be fruitful in so far as first principles and fundamentals, more especially in respect of rate of heat transmission, are not violated.

The foregoing conditions of design of the Diesel engine prevent it from being a cheap and light prime-mover. Increased experience, better materials, more efficient utilisation of such masses as are required to cope with the pressures of the cycle, together with standardisation, will in due course effect a reduction in these diabilities.

At present the cost can be stated to be from 25 to 33 per cent more than for a steam plant, depending on the type of auxiliaries applied to the oil-engined ship, and whether comparison is made with reciprocating or double-reduction turbine steam machinery. The higher cost is minimised in effect by the greater cargo-carrying capacity sometimes possible by the adoption of oil engines, or alternatively by the fact that a smaller Diesel-engined ship serves to give earning capacity equal to a steamer. The economy of operation possible with the oil engine is such that, granted reliable performance, the extra first cost is speedily balanced by the increased profits obtainable. The total saving for 200 days' sailing per annum by installing Diesel instead of steam machinery is given for wages and keep, fuel and oil costs, in the case of a single-screw ship of 1,000 B.H.P. and also of a ship of 2,400 B.H.P.; twin screw in the case of Diesel engines and single screw in the case of steam. No estimation has been made regarding the other savings generally possible, the most important of which is additional cargo capacity, no stand-by losses, and higher average speed, more particularly when the oil is compared with the coal-fired ship. The figures, however, for the savings in fuel, lubricating oil, wages and keep are, it will be admitted, sufficiently attractive to merit close attention by shipowners to the Diesel system of propulsion, when full comparisons can readily be made to meet the specific case of any particular type of ship or class of trade.

That after 10 years of experience, keeping in view the last five years of intensive service, reliability can be obtained with the Diesel engine will not be gainsaid. The position of this new prime mover is not yet, however, sufficiently secure for short cuts towards the lightening or cheapening of the engine to be undertaken without the most careful consideration. The available knowledge demands that oil engines shall be rated at a moderate power output per unit of swept cylinder volume with the consequent low-temperature gradient through, and stresses in, the metal exposed to combustion temperature. Ample strength and rigidity must be given to those parts that are stressed by the pressure of the cycle, and a high quality of workmanship is essential for all the principal units. So long as labour conditions do not very appreciably change, the Diesel oil engine will increase rapidly in importance, with the full realisation of the enormous advantages of liquid fuel as a marine combustible. Satisfactory distribution of fuel throughout the world seems assured, and any future shortage will first affect those plants less able to compete in regard to economy of consumption of liquid fuel. Powers up to 6,000 or even 8,000 B.H.P. per ship with twin screws (500 B.H.P. per cylinder) can be looked for in the very near future, and gradual increases will take place successfully by short steps consolidating each advance as gained, before proceeding to the attainment of higher outputs.

Below 800 to 1,000 B.H.P. per cylinder it can now definitely be stated that there are no limiting conditions. With increasing size of cylinder altered methods of construction will be called for to minimise the effect of temperature gradient, and may even be compelled by marine requirements in order to reduce size and weight.

The longed-for internal-combustion turbine does not yet appear on the horizon. The relative inefficiency of high-pressure turbo-compressors, the losses consequent upon the transference of the working medium from the compressor to the turbine and the difficulties experienced with available materials when subjected continuously to the high temperatures necessary for economy have so far been insuperable barriers to development.

What the future holds in store cannot be forecasted. Sufficient for the moment is the fact that there are many known problems with internal-combustion engines to which only at best comparatively clumsy solutions have so far been found. Improvement of the present state of this science calls for the highest efforts of engineering skill, and the time has arrived when energy and enterprise expended in such a direction may look expectantly for the just reward of a broadening application to marine work.

* Proceedings of the Junior Institution of Engineers, May, 1914. "High Power Diesel Engines; Their Development for Marine Service."

BELT conveyors are to be used extensively at the new central power station of the Milwaukee Electric Railway and Light Co., construction of which is now under way. This will be the largest station in the world utilising powdered coal for the generation of steam, and this fact makes a brief review of the conveyor system of added interest.—*Calvert's Mechanics' Almanack.*

ALUMINIUM AND ITS ALLOYS.

By W. Rosenhain, D.Sc., F.R.S.

Aluminium is of very widespread occurrence in nature. Many rocks and all ordinary clays contain a considerable proportion of aluminium. These materials, however, which are of the nature of impure silicate of aluminium, are not at the present time available for the production of the metal. The reason is that they do not readily lend themselves to economical treatment for the production of metal. The only sources of aluminium which are extensively used at the present time are the deposits of bauxite, which occur in various parts of the world. This mineral consists largely of oxide of aluminium (Al_2O_3), which is contaminated with varying proportions of iron and silica. One of the main difficulties in the metallurgy of aluminium, however, arises from the fact that the metal once produced cannot be readily refined. Consequently, any impurities which are present in the ore in such a form that they become incorporated in the metal, cannot subsequently be removed economically. For the production of pure aluminium, therefore, it is necessary to utilise pure material, and this applies equally to the ore and to other materials which come into contact with the metal during manufacture.

Any steps which can be taken to secure a reduction in the price of aluminium are of vital importance to the industry of that metal and its alloys. The use of aluminium alloys as materials of engineering has become firmly established in certain directions during the war. If, however, it is hoped that their application may be extended to wider fields, it is essential that the cost of these materials should be very considerably reduced. Weight for weight, alloys are now obtainable which are far superior to steel, but, on the other hand, steels—even the more expensive variety of alloy steels—are very much cheaper than aluminium or its alloys. Owing to the relative lightness of aluminium, however, this metal and its derivatives could successfully compete with steel even if the price of aluminium were still three times that of steel per ton. Even such a ratio, however, would require a diminution of the price to rather less than one-third of the lowest price level reached by aluminium before the war. It is obvious that such a development cannot be expected unless means are devised for utilising cheaper raw material and employing less expensive methods of treatment.

The thermal properties of aluminium are also remarkable and interesting. The thermal conductivity has a value of 0·51, as compared with 0·11 for iron. Combined with this high thermal conductivity, aluminium also possesses a very high specific heat (0·21), as well as a high electrical conductivity, which is about 60 per cent of that of copper for equal volume, or 200 per cent for equal weight.

The chemical properties of aluminium are also remarkable, and of very great importance. In the first place, in might almost be regarded as surprising that metallic aluminium can exist at all in an atmosphere containing oxygen and charged with moisture. We have already noted that the metal possesses a strong affinity for oxygen, and this property is utilised metallurgically. In the first place, there is the well-known thermite process in which iron and other oxides are reduced by the action of aluminium powder without the aid of external heat. Further, in the production of steel, and also in other metallurgical processes, aluminium is sometimes introduced as a cleansing and reducing agent at the end of the operation. Very large quantities of aluminium are used for this purpose in the steel industry.

In spite of this very strong affinity for oxygen, however, aluminium exists when exposed to ordinary air for a very long time without undergoing appreciable charge. This apparent resistance to corrosion is due to the fact that the surface of the metal becomes coated with transparent but protective film of oxide. The reality of the existence of this transparent surface film can be readily demonstrated, as has recently been done by Dr. Seligmann, by heating a sheet of thin aluminium foil. As a result of such heating the aluminium foil becomes largely oxidised. In spite of this oxidation it retains its perfectly metallic appearance when viewed by reflected light. When, however, such a piece of oxidised foil is held up to the light, it is found to be very largely transparent. Similar evidence can be obtained from aluminium powder. Such powder can, by prolonged heating in a moist atmosphere, undergo very considerable oxidation, involving an increase of weight of more than 25 per cent. But the powder thus oxidised does not appreciably change in appearance.

The presence of a protective film on the surface of aluminium can also be demonstrated by the effects which arise when that film is removed. When aluminium is exposed to the action of water, or even of a moist atmosphere, the protection of aluminium and its alloys from corrosion is a matter of very great importance. In ordinary dry air, such as is met with in the interior of houses, railway carriages, etc., aluminium and many of its alloys preserve an untarnished surface for a very long time. No doubt it is this property which has given the metal the reputation which it appears to enjoy in some quarters of being particularly incorrodible. When, however, it is exposed to the action of water, and particularly of sea-water, very different results arise. Particularly if there is any friction, relatively rapid corrosion may set in, and this is liable to occur where the metal is exposed merely to spray and not actually immersed in the water. Protection can, to a considerable extent, be ensured by the use of protective organic coatings, such as varnish or bituminous paints. Care must, however, be exercised in the choice of pigments employed for the coating of aluminium. It has been found that paints containing lead oxide are liable to be injurious, chemical action taking place between the aluminium and the oxide contained in the paint. Aluminium and its alloys can also be protected from corrosion to a considerable extent by electrolytic means. Aluminium placed in contact with steel, and exposed to water, is protected to a very large extent, but the corrosion of the steel is correspondingly accelerated. This is a result which is surprising at first sight, in view of the relative position of aluminium and iron in the electro-chemical scale. It is due, however, to the

fact that the aluminium rapidly becomes coated with oxide, and thereby polarised electro-chemically.

The use of aluminium alloys of a particularly corrodible character as metallic protectors for aluminium, or its less corrodible alloys, has also been suggested recently.

We turn now to consider the mechanical properties of pure aluminium, and it will be seen at once that from this point of view the metal is very disappointing. The tensile strength of commercially pure aluminium in the cast, rolled, annealed, and cold rolled states is shown in Table I., together with corresponding data for steel and brass.

TABLE I. PURE ALUMINIUM.

Condition.	Yield Stress. Tons to sq. in.	Ultimate Stress. Tons to sq. in.	Extension. Per cent on 2 in.
Cast. 1 in. diameter	2·3	5·22	37
Chill shaped sand	2·5	4·90	24
Rolled. Rod 13–16 in. diameter	6·5	7·20	30·5
Sheet. (Hard)	9–10	10–11	5–6
14 gauge (soft)	1·2–2	6–7	19–25
Drawn. Rod 13–16 in. diameter	8·5	8 7	19·5
Rolled *Mild Steel*	16·4	30·0	41
Rolled *Brass*	21·5	25·0	35

It will be seen that the figures for aluminium are comparatively very low, and, as a result, the uses of aluminium for engineering purposes where strength is required are very limited indeed. It is actually valued mainly for its lightness, its very great ductility and its colour, and power of resisting atmospheric corrosion. It is accordingly used wherever lightness is essential without great strength. It is used in the form of castings, rods, wires, and sheets, including among other uses, a considerable application as a conductor of electricity. It is also employed for panelling, and, in the form of powder, for paints, explosives, etc. One use with which many people are familiar is for cooking utensils. For more serious purposes of engineering, however, it is necessary to use alloys of aluminium which possess very much greater strength and hardness. It is, therefore, not surprising to find that the development of the engineering uses of aluminium has depended entirely upon the discovery of alloys capable of combining, as far as possible, the light weight and other advantageous properties of the metal itself, with a greater degree of strength and hardness.—*Journal of the Royal Society of Arts.*

OIL-MINING ENGINEERS. The oil-producing interests of Great Britain have contributed £122,850 towards the £500,000 for which the University of Birmingham is issuing an appeal. The Anglo-Persian Oil Co., the Anglo-Saxon Petroleum Co., Viscount Cowdray, and Sir Marcus Samuel contributed £25,000 each, Mr. D. Elliott Alves £12,500, the Anglo-American Oil Co. £10,000, the Central Mining and Investments Corporation £250, and the Trinidad Leaseholds Ltd £100. Under the direction of Sir John Cadman, the School of Mining at Birmingham has established an enviable position, and from its department of petroleum technology, students competent to deal with modern drilling machinery proceed to all the great oilfields of the world.

SWEDISH IRON INDUSTRY'S DIFFICULTIES.

Ironworks Reduce Production.

On account of the depressed state of affairs, iron work in Kopparg-Hotors, which during the last two years has been reduced to one-half, will in the near future be further curtailed. It has been impossible to sell pig-iron during the last two years, and even for so-called raw (crude) bar iron it has been most difficult to find a market.

The sale of "Lancashire" iron is very slow, although it is true that it has continued even since the war, and it is therefore being considered as to whether the rolling plant in Vig shall close down. The rolling plant in Jadraas has been standing for some time. The stoppages are chiefly on account of the difficulty in disposing of the products, especially "Lancashire" iron.

It is suggested that the introduction of the eight-hours day has increased the cost of production approximately 50 per cent, and that to maintain the previous output and counteract the increased cost, the men need to increase their present output by 34 per cent. The present cost of production is so high that the export market, mainly exotic lands, such as India, China and Japan, has been lost; those named have bought worse but cheaper qualities such as, for example, German "Martin"-steel, and manufacture here ceases as existing orders are completed.

In Ljusne, Sweden's largest "Lancashire" ironworks, the production has already been reduced in the south portion of the works, which comprises blast-furnaces, rolling mill and "Lancashire" forges. As the works have only orders which will last for a few weeks, it is clear that even the north part of the works must also close down, when only the north blast-furnaces will remain in operation. One of the directors, Herr Heckerman, purposes to go abroad himself at the end of the month to see if anything can be done to help in the disposal of their goods.

At the Oxelösunds ironworks there is also to be an early reduction of production. Of this company's produce, foundry cokes, cast pig-iron and tar have especially poor selling possibilities.

To close down those works, however, is a big and involved step to take, since such a closing down cannot be made merely for a short time, but must continue for a more or less long period, but, as the present outlook is very black, it seems to be inevitable, says Director G. K. Hamfeldt.

The output at the centre works in Horndal's works has been further suspended, by which about 15 men have been thrown out of work.

A further 40 men have been thrown out of work by the closing down of the rolling plant at Nas works in the parish of By.

Notices to Terminate Agreements Given.

The already harassing situation in the iron industry has become more so owing to the "Metallindustriarbetareforbundt" (Ironworkers' Union) giving notice from November to terminate the agreement made in spring with the employers: by that are both the Ironworks Agreement and the prolongation clause of December, 1919, under notice to terminate at the end of this year.

The circumstances, or conditions, of these agreements have, however, been reasonably elastic during

recent months, and negotiations have been carried on continuously since the eight-hour day Act came into full operation on the 1st of January. The local negotiations respecting piece rates have, in general, turned out well and thereby a good work will already have been done before the termination of the agreements.

The difficulty in the present acute situation will be the division and allocation of working hours. On this matter the central negotiations committee has stepped between the "Metallarbetareförbundet (Ironworkers' Union) and the "Järnbruksförbundet" (Ironworks Society) with the co-operation of Director Allan Cederberg. The negotiations broke down, however, recently, it being impossible to reach an agreement between the two parties.

Open conflict may, says the "Social Democrat," be expected any day.

HARBOUR IMPROVEMENTS IN JAPAN.

The Hyogo Prefecture, one of the most prosperous districts in Japan, both for the commercial and industrial points of view, has a plan for the improvements of its ports.

Amagasaki, in the western suburb of Osaka, Japan's industrial centre, will be improved at a cost of 1,750,000 yen. The present harbour covers an area of 37½ acres, which it is proposed to increase to 166½ acres. The work will extend over several years. Three quays, each 1,200 ft. long, and another of 1,500 ft. will be built, and the mouth of the harbour will be widened to 300 ft. The new harbour will be 6 ft. to 13 ft. deep at low tide. The present harbour accommodates 985,175 tons (gross) of ships a year, handling cargo to the amount of 1,141,894 tons (both import and export combined).

Nishinomiya and Imazu, two adjoining rural ports between Osaka and Kobe, will be combined into a large new harbour at a cost of 890,000 yen. The two ports at present cover an area of 19 acres, which it is intended to increase to 83 acres. About nine acres of sea will be reclaimed for the erection of warehouses, landing stages, etc. One large bow-shaped quay, 3,000 ft. long with two entrances, each 180 ft. wide, will be constructed. The present accommodation of the ports combined is 309,800 tons of shipping and 366,392 tons of cargo.

Mikage, near Kobe, will have its harbour improved at a cost of 1,800,000 yen. The new harbour, which will be 8 ft. deep at low tide, will cover more than 29 acres. Eight acres of sea will be reclaimed, of which 2½ acres will be used for a landing stage. Two quays, each 900 ft. long, will be constructed besides two harbours each with a mouth 180 ft. wide. The present harbour can accommodate 113,050 tons of shipping.

The port of Gunke, on the Western Coast of Awaji Island in the Inland Sea, will be improved at a cost of 605,000 yen, of which 290,700 yen and 57,000 yen will be used for the construction of a quay and breakwater respectively. The present capacity of the port is 223,201 tons of shipping.

Murotsu, a sheltered harbour on the Western Coast of Awaji Island, will be made into a regular port at a cost of 405,000 yen, with large piers, landing stage, etc.—Reuters' Trade Service.

OIL FOR THE RAILWAY ENGINE.

CAN IT TAKE THE PLACE OF COAL?

The suggestion has been made in the course of the past few days that, in the event of a future coal strike, many trains will be run with oil fuel. The ground on which it has been put forward have not been stated, and inquiries made among railway authorities lead one to conclude that it is no more than a premature attempt to read the signs and portents of mechanical development on our railway systems. More than one railway company has recently been conducting experiments with oil-fired locomotives, and the experiments have shown that methods of using oil fuel have been devised by means of which a very considerable degree of efficiency in raising steam and traction power can be achieved.

One of the most interesting experiments of the kind has been carried out by the London and North-Western Railway Company, which fitted a locomotive with the "Scarab" oil-burner some months ago, and has since been running it regularly between Euston and Birmingham. The Scarab burner enables crude oil to be atomised for furnace use. It consists of an open-ended tray on to which the oil flows by gravity from the tank. Spreading over the tray, the oil passes over the open end in the form of a sheet, and is then vaporised or atomised by a high velocity jet of steam so that it can be very easily ignited. Results quite satisfactory from the mechanical point of view have been obtained from the locomotive in its daily journeyings. The locomotive, which formerly burnt coal, was selected because it was of a type which had a narrow, deep fire-box, and therefore presented difficulties in the way of fitting a satisfactory oil-burning system. The minimum permissible clearance between the bottom of the ashpan and the rails was such that some ingenuity was needed to fit a suitable oil-burning "ashpan," with its necessary air-ducts. But one of the great merits claimed for the Scarab oil-burner is that it does not necessitate any structural alterations in the locomotive, and the makers declare that, given the requisite materials, a locomotive can be converted from a coal-burner into an oil-burner in four days. In these facts, perhaps, lies the genesis of the forecast that a prolonged coal strike will effect a revolution in the use of fuel on the railways.

Inquiries made at the London and North-Western Railway Company's locomotive department at Crewe go to show that the oil-fuel locomotive is still regarded as in the experimental stage. The efficiency of the Scarab system is accepted, but a larger question is involved. What will be the ultimate expense of oil-fuel locomotives be as compared with locomotives that burn coal? This is a complex problem, and it has not yet been worked out. Some change in economic circumstances might make the oil-fuel locomotive clearly a commercial proposition, and in that event there would be conversions on a large scale. But labour and material would be necessary, and it does not in any way invalidate the claim of the makers of the Scarab burner to say that it might not be possible to carry out conversions very rapidly.—*Manchester Guardian.*

Brayshaw Furnaces and Tools Ltd.—This firm informs us that they are supplying a large number of case-hardened boxes of varying size and shape. They are made of first-class boiler-plate metal and solid welded.

AMERICAN ENGINEERING NOTES.

Whenever trouble comes "conservation" becomes a popular word, and in this country at least there are lots of room for its practical application. Dr. Fieldner, of the U.S. Bureau of Mines, has pointed out a bung-hole waste of very great import in these days of almost world-wide fuel shortage. He says that 30 per cent of the gasolene now used in the United States is wasted through defects in carburettors. And the situation with regard to gasolene waste should be of unusual interest to all the owners of the 7,500,000 automobiles and trucks in the United States. It should, too, be of just as much interest to British owners of motor-driven vehicles.

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There are consumed by the motor vehicles of this country approximately 3,400,000,000 gallons of motor spirit every year. At present prices this fuel is worth from 31 to 34 cents a gallon, according to the quality and the location in which it is purchased. Our authority points out further that if consumers saved only 30 per cent of the petrol now wasted in America the national petrol fuel bill would be cut by 346,000,000 dols. a year. Then, again, Dr. Fieldner maintains 20 to 30 per cent of the gasolene which the average car and truck owner is wasting comes from the use of a too rich gasolene mixture.

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The doctor went on to declare that a true economy in the automobile world could be obtained only by giving more attention to carburettors, which should be carefully adjusted and made "foolproof."

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Some time ago the question was asked whether the capacity of the pipe and casing making mills of the United States was adequate to meet the demands of the oil industry. Mr. Howard H. Cook, assistant secretary of the American Iron and Steel Institute, New York, has sent to the American Petroleum Institute a list of the manufacturers of wrought iron and steel pipe and boiler tubes, but states that the list gives the total capacity of the various plants engaged in the trade, but it is not possible to divide the capacity into standard black pipe, oil country goods, boiler tubes, etc., but that no doubt the list will give a basis on which a judgment as to the sufficiency of the present capacity can be formed. The list embraces 26 mills with a total annual capacity of 3,937,000 gross tons.

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I learn that the Germans, who for some time before the war were active in pushing the business of installing hydro-electric installations in Cuba, at the same time keeping their activities under cover as much as possible, have been selling out. The Elektrische Licht und Kraftanlagen Gesellschaft has disposed of its holdings in the electric light companies in three Cuban cities. It came out that there had been the usual juggling to conceal ownership, etc.

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In the first eight months of this year the U.S. exported 1,150 locomotives, nearly 200 more than in the full year preceding and more than twice as many as were usually exported annually before the war. Before the war the export of locomotives was concentrated in the hands of the great steel-producing countries, Great Britain, Germany and the United States. Under these circumstances American sales to Europe were very small. During the war, however, the United States was called upon to supply locomotives to Europe, and in 1918 even sent 241 to England. At this distance, it seems to us, so many examples of this character ought to set the British workman as well as employer to doing serious thinking. But as the vice-president of one of our locomotive works said to me recently, "This is our opportunity, and we'd be fools not to take it."

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A practice, peculiar I think to America, of giving free bonuses to attract new industries to a town was thus commented on by a western Chamber of Commerce secretary this week in an address before a gathering of secretaries :

"Years ago some enthusiastic soul conceived the idea of buying industries by giving bonuses. This expensive experiment appeared in the form of cash, free land, tax exemption, etc. Factory chasers, competing and spurred on by alleged civic pride eliminated the more conservative organisations, and, of course, the bonus hunter went where the bribe was largest. Because of the bribes offered hundreds of industries were established in towns which were not suited for them becoming ultimate failures, with a loss to both owner and bonus giver."

We had to live a long time before we learned this plan was a failure.

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An interesting comparison of post-war iron, steel and metal prices of the year directly following the termination of our Civil War with those of to-day was made recently by the *Iron Age*, showing that the inflation movement at that time was in every way as severe as that following the world war. In fact, prices in 1866 were actually at the level of or above the present market.

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The Pennsylvania Railway has commenced the erection of one of the largest general repair shops of the system at Wheeling, W. The cost will be about 4,000,000 dols.

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Standardisation is an article of manufacturing faith in America. So to be orthodox the makers of elevators expect to standardise their products as an outcome of the conference on this question which lasted three days and terminated October 30th.

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Camphor is a substance used in many industries, which, so far as we are concerned, has been controlled by the Japanese Monopoly Bureau in New York. American celluloid manufacturers, who use a lot of the stuff, are in revolt against the monopoly. Japan has heretofore had this market in her own hands. Now, it seems possible that her hold may be broken with the aid of China.

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The Erie Railway is to experiment on a good-sized scale with a new straight air brake. An order has been given to equip 49 new steel suburban passenger cars with this novel automatic straight air brake device.

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At the Engineers' Societies Club recently Dr. Bumstead, professor of physics at Yale, pointed out that the chemists of the country are so well organised as to need little or no help towards co-operation with each other, but that they were interested in developing co-operation between themselves and men in other scientific lines for the benefit of both. He added that the representatives of the United States had been requested by the International Chemical Union at Brussels to assume the task of preparing and publishing critical tables of physical and chemical constants, the utility of which in science and industry could hardly be exaggerated. He also declared that from 150,000 dols. to 200,000 dols. would be required for the completion of these tables, to the cost of which a number of industries had already pledged a substantial amount.

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The Reno Nevada Chamber of Commerce is turning its attention to the development of the little known minerals and metals of that State. A bureau of mining information has been established with the purpose of bringing together buyers of these minerals and owners of deposits of them.

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A Shipping Board vessel of 11,800 deadweight tons and electrically driven has made her trial run. The Eclipse, as she is named, is a freighter, and as a result of the satisfactory showing she is said to have made, Admiral Benson made it known that ten other of the Board's commercial freight carriers will be similarly equipped. This being a new departure in merchant ships, the experiment and the practical results these ships show in every-day operation will be watched with much interest by both land and marine engineers.

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Another big contract has come to a New York firm from abroad. The Foundation Co. is to construct a water supply, do paving and sanitary work in Lima and Callao, Peru. The sum of 1,000,000 dols. is to be expended within 10 months. And contingent on proper financial arrangements being put through the contract provides for a further expenditure of between 10,000,000 dols. and 15,000,000 dols. in some 30 other Peruvian towns on works of a similar character. The contract is made on terms of cost plus 10 per cent.

* * *

In this State of New York alone reports from 1,570 manufacturers show that approximately 100,000 workers have been laid off during the past six months.

FOREIGN NOTES.

American Company to Supply Locomotives for France.—The American Locomotive Co., New York, has received an order from the Paris-Orleans Railway for the supply of fifty 100-ton Pacific locomotives.—Reuter.

French Importation of Boring Plant.—In order to encourage the discovery of oil in France, the Minister of Finance has authorised the temporary admission without tax of boring implements used in testing the presence of petroleum.—Reuter.

Proposed Central Shipping and Shipbuilding Bureau in Sweden.—A proposal has been brought forward for the establishment of a central bureau of Swedish shipping and shipbuilding with an experimental tank. A committee which was formed to investigate the matter found that the total cost of such an establishment would be about Kr.2,250,000.—Reuter.

New Companies in Sund.—Director H. E. Hammarberg, of Sund, with Dr. J. A. Almquist and Captain Axel Thuresson, both of Stockholm, have formed a new company in Sund, Norrland, for the purpose of working water and electric-power stations. The share capital is fixed at Kr.1,750,000 minimum, and Kr.4,710,000 maximum, and will be divided into Kr.100 shares. The same gentlemen have also formed a new shipping company in Sund, with a share capital fixed at a minimum of Kr.628,000 and a maximum of Kr.1,884,000.—Reuter.

The Australian Metal Industry: Potentialities of Newcastle.—Mr. G. D. Delprat, manager of the Broken Hill Proprietary Steelworks at Newcastle (N.S.W.), in an address to the Millions Club, Sydney, predicted a great future for Newcastle which, he said, would be the industrial capital of Australia. Last year the company produced 296,000 tons of pig-iron. Next year it was hoped to increase this figure to 450,000 tons, as well as to make steel by direct process. Many allied industries, added Mr. Delprat, were being established at Newcastle, which possesses great potentialities.—Reuter.

Sale of Power at Madrid. The Madrid Water Board recently announced the adjudication of power accumulated by its hydro-electric station at Torrelaguna. The offer consists of 36,000 k.w.h., at a minimum of 1,800 pesetas per day. This will form a considerable increase of resources for consumers of power and light in Madrid, who are short of both. When the works undertaken by the two electrical companies supplying the town are completed it is probable that the consumption of coal will be much reduced, to the great advantage of the said companies, who find the use of fuel at the present prices very expensive.—Reuter.

Across Europe by Aeroplane.—The aeroplane service from Paris to Prague is now running daily with perfect regularity, directed by the Compagnie Franco-Roumaine de Navigation Aerienne, with a capital of Fc.10,000,000, which is responsible for this new link across Europe. The service is made *via* Strasbourg, where a stop is made; the aeroplanes employed are luxurious passenger machines, and letters and parcels are also carried. The journey between Paris and Strasbourg is effected in 2½ hours, and the whole distance between Paris and Prague is six hours. The price of a single ticket from Paris to Strasbourg is Fc.500, the return costing Fc.800, the ticket being available for 15 days. Paris-Prague costs Fc.1,500 single, Fc.2,400 return, available for 20 days; and Strasbourg-Prague, Fc.1,000 single, Fc.1,600 return, available for a fortnight. These prices include motor transport between aerodromes and towns. Reuter.

The Recovery of Belgian Industries. The Ministry of Industry, Labour, and Food Supply published in June and December last year figures, rapidly compiled, giving some idea of the extent of the recovery of Belgian industries. An investigation which has recently been carried out by the Administration of Mines and the Labour Inspection Department now gives a comprehensive view of the situation in Belgium at the present time. Industrial establishments employing more than 20 workers employed in June 1920, 606,960 workers as against a personnel of 650,889 in June, 1913; that is to say, the number employed in 1920 represents 92 per cent of those employed in 1913. In December of last year the number only amounted to 72 per cent. The mining industry is now employing even more workers than it did in June, 1913. With regard to production during the first six months of 1920, of the 3,666 establishments existing in 1913 which furnished figures showing their production in 1920, 1,407, or 38 per cent of these concerns, recorded a production exceeding 75 per cent of their pre-war production. Rather more than half of these establishments are now employing more than three quarters of their pre-war personnel. The most important reasons for inactivity are: (1) Lack of material resulting from destruction or pillage by the enemy, which it is estimated accounts for 21·09 per cent of forced idleness. (2) Lack of capital and delay in payment of indemnities (9·77 per cent). (3) Lack of orders (8·20 per cent). (4) Lack of raw materials (7·05 per cent). (5) Lack of labour (6·45 per cent).—Reuter.

Japanese Government Ironworks.—According to the Osaka Asahi, the new undertakings of the Japanese Government ironworks at Yawata Kiushiu, for the fiscal year 1921 are as follows: "On the whole, there will be no material change from the plans for the present year, with the exception of the output of pig-iron, which is estimated at 470,000 tons, an increase of approximately 170,000 tons over this year. This increase is attributed to the additional furnace (No. 6), now under construction, which is expected to be completed in February, and to be in working order in March. The ore required for this furnace will be about 720,000 tons, the entire quantity to be obtained from the Taye mine, in China. The Akatani mine, in Niigata-ken, which is under direct control of the Government ironworks, and which is now in course of preparation, is not expected to be ready during the next financial year. At present a plan is under contemplation for the establishment of a depot for ores at Niigata. It is, therefore most important that the Niigata harbour works be completed at as early a date as possible for the transportation of ores when the new mine is ready. The harbour works are expected to be finished in 1924, and will accommodate a 3,000-ton steamer, the depth of water being 25 feet. Pending completion of this new harbour scheme, vessels of 1,000 tons will be put on the transport service. The new harbour works are to be used only in emergencies, as the Tayeh mine constitutes the principal source of supply. No. 2 steel plate works will be completed in October, and the manufactures, it is anticipated, will be placed on the market from the end of the current year. They will turn out 300,000 tons of steel plate, measuring 13 in. by 12 ft. by 50 ft., which will be used mostly for naval shipbuilding purposes."—Reuter.

New Locomotives for Spain. The first locomotive of the 50 which the Maquinista Terrestra y Marítima of Barcelona is constructing for the Madrid-Zaragoga-Alicante Railway has been delivered and put into service. The following are the principal characteristics of the new locomotive: Weight empty, 77,400 kilogrammes; when in use, 86,600 kilogrammes; weight of tender, empty, 24,620 kilogrammes; in use, 55,800 kilogrammes, 6,000 kilogrammes consisting of fuel and 25,000 of water; adhesion weight, 65,600 kilogrammes; tractive power, 14,790 kilogrammes; distance between the extreme axles of the engine and tender, 17,770 metres; between buffers, 20,855 metres. The locomotive has two cylinders, each of 620 millimetres in diameter, with a stroke of 660 millimetres. The heating surface of the boiler is 280 square metres, giving a working pressure of 14 atmospheres and a force of 2,000 H.P. There are 214 tubes of 50 millimetres diameter, and 26 of 133 millimetres. The distance between the tube plates is five metres. These locomotives are somewhat similar to the American and German ones of the series 1,301-1,333 of the M.A.Z. company, as far as the number and distribution of the axles and the diameter of the wheels, which are equal, are concerned. They differ from those of the series 1,300 in that the latter are compound and driven by superheated steam while the Barcelona locomotives, also driven by superheated steam, have twin cylinders, the boiler being also much larger. The frame, boilers, and axles are manufactured by the Altos Hornos de Vizcaya; the wheel cores of moulded steel by the Talleres de Deusto; the other parts in moulded steel by the Hijos de Dionisio Escorsa, of Barcelona. Only the tyres, tubes, copper plates, and certain forged parts come from abroad, as also the injectors and braking apparatus. The *Ibérica*, which gives these details, says that in view of the fact that Spanish copper foundries are actually engaged on extensions of their works in order to be able to produce large copper plates, that works are being installed for the manufacture of jointless steel tubes (Babcock & Wilcox), and that tyres are already produced at Beasain, it may be prophesied that within a year the Spanish locomotive industry will be completely independent of foreign manufacturers.—Reuter.

Trade Items, Notes, &c.

Harland & Wolff on the Thames.—Thames-side workers are pleased at the prospect of more work owing to the fact that Messrs. Harland & Wolff, the noted Belfast firm of shipbuilders, are coming to establish works on the Thames. It must not be assumed, however, that they propose at present, at any rate, to construct ships on the great river, but they are to take over the whole of the engineering repairs and constructional work of the Port of London Authority, and to construct buildings of a permanent character of the value of £300,000, in addition to two slipways for ship-repairing and shipbuilding purposes. Messrs. Harland & Wolff will take over all the staff formerly employed by the Authority on ship repairing and engineering work, and they are to have absolute preference on the work of the Port of London Authority. Where other firms are employed on such work, the company will be paid a commission of 5 per cent on the cost. This new move will have the immediate effect of diverting many of the firm's great ships to the Thames, and it is not too remote that at some future time shipbuilding works may be established by the firm in the neighbourhood of Dagenham, down the river.

Tests of Bearing Metals.—The tests at elevated temperatures of Babbitt bearing metals, four of which were investigated in connection with the Society of Automotive Engineers' specifications for such material, have been completed by the Bureau of Standards. As was expected, the yield point and ultimate strength decreased rapidly with increasing temperature. It would appear that Babbitts containing lead lose their strength more rapidly than those with a tin base. Brinell hardness measurements have also been made on these four samples, and will be repeated later on larger specimens. In order to study the effect of small quantities of lead on the physical properties of a high-grade tin-base Babbitt, varying percentages of lead have been added to metal made in accordance with specification No. 2 of the American Society for Testing Materials, and the physical properties of the various combinations thus secured will be studied at ordinary and at elevated temperatures. A thermostatically-controlled oil bath has been constructed for annealing specimens over long periods of time in order to determine its effect on the mechanical properties of the Babbitts.

Oil Fuel for Manx Steamers.—It is announced by the directors of the Isle of Man Steam Packet Co. that experiments are about to be made in connection with the application of oil fuel to steamers of their fleet. One of their largest passenger-carrying vessels is first to be fitted, and on the results of the tests will depend whether the whole of the company's ships will be fitted in like manner with liquid fuel. This decision is of great interest, as the Manx company has been able to boast of the fact that it is the oldest passenger-carrying steamship company in the three kingdoms. Additional interest centres in the undoubted fact that a citizen of Peel (one of the towns in the Island), Mr. J. J. Kermode by name, was one of the pioneers in the practical application of liquid fuel as the means of propelling sea-going vessels. Upwards of 30 years ago, Mr. Kermode established himself as an engineer in Liverpool, and to-day he is in the proud position of having had many of his devices for oil fuel in its application to ships adopted by the Admiralty on many of their warships, and his patents are now being largely used on many vessels in the British merchant service.

An Improved Process for Steel Making.—An improvement of the acid Bessemer steel process, which aims to reduce the cost of making steel, and to decrease the possibility of low-quality steel in the process, has been recently invented by a member of the Department of Mining and Metallurgy of the University of Wisconsin. The purpose of the invention is to use basic material for the lining of the Bessemer converter instead of the acid lining now used, in order to prevent corrosion of the interior of the converter, and to reduce the amount of air pressure and engine power now required. With the basis lining composed of lime magnesite, dolomite, oxide of iron, or the like, the inventor believes it will be possible to use lower pressure and cut down the time of blowing about 30 per cent. To prevent corrosion of the converter bottom the inventor proposes a number of different kinds of linings for various acid Bessemer converts, and details the particular parts of the converter that require such a basic lining, while the remainder of the converter has an acid lining to resist corrosion by the acid slag. The invention is applicable to the bottom-blown type, side-blown type, and other kinds of Bessemer converters operating on the principle of making steel by blowing air through a body of molten iron.

REVIEWS.

HEAT ENGINES. By David Allan Low. London: Longmans, Green & Co., 39, Paternoster Row; 17s. 6d. nett.

One lifts this 600-page volume with feelings of expectation, and it is so engrossing that when laid down one is satisfied. There is nothing so disappointing to the student as to spend laborious hours endeavouring to master the contents of a book and feel, when the last page has been turned over, that he has been cheated. Most of us have had the experience. This volume cannot, of course, be read in the ordinary sense; its contents can only be assimilated by patient study, but Professor Low has achieved in his treatise on heat engines the supreme distinction of having made a subject which is usually considered "dry" intensely interesting. There is no intrinsic reason why the study of any section of engineering science should not be fascinating, but many of our most brilliant engineering scholars have not the gift of expression. Professor Low always shows freshness and originality in treatment of a subject, hence "Heat Engines" is ably written, and has the quality of unity from cover to cover. It compares favourably with the same author's "Applied Mechanics," and no one subject is overdone at the expense of another. In a book of this kind the temptation for an author to unduly labour a subject for which he has a predilection is very great.

The study of heat engines is now so comprehensive that it is essential for the engineer to specialise. The evolution of the steam turbine and the internal-combustion engine has been rapid, and now, immediately apprenticeship days are over, the engineer must specialise to excel. All heat engines are governed by the same principles, and a preliminary study of the whole field will always be advisable. It was much easier to write a treatise on heat engines a decade ago than it is to-day, and the completeness of this volume is surprising. Special features of the book are the illustrations and the exercises. Over 80 per cent of the exercises are stated to be original, and they have been selected with the examination papers for the various examining authorities in view. The illustrations, which are numerous, are also stated by the author, in the preface, to have nearly all been specially prepared for the work.

The volume is divided into 24 chapters, with an appendix consisting of tables. The first chapter deals with the theory of heat. Intervening chapters on the properties, the expansion, and compression of gases, and combustion and fuel bring us, at chapter six, to steam boilers. A study of reciprocating engines begins in chapter twelve. The subject of steam turbines occupies over 50 pages, and is quite up to date, dealing with the latest work on the gearing of turbines. It would be folly to suggest that the chapter is a complete treatise on "Steam Turbines," nor do we think the author intends it to be such, but it is a good introduction. This can also be said of the chapter on internal-combustion engines, which are still in the experimental stage.

There will never be finality to engineering progress; therefore such books as this soon become out of date. The ground work, however, is so sound that with periodical revision it is likely to become a standard work. It must have occasioned tremendous labour, but it has surely repaid the author, for it is an excellent book.

THE COMPLETE AIRMAN. By G. C. Bailey. London: Methuen & Co. Ltd., 36, Essex Street, W.C.2; 16s. nett.

There were few books on aviation a decade ago, but with the great development of the science, which was stimulated by the war, the demand for knowledge, both on the theory of flying and on the mechanical construction of flying machines, has had the inevitable effect, and now there is a great deal of literature on the subject. Many of the writers in this field are quite unqualified to deal with the subject in any but the most superficial way, because the problems of aviation are essentially engineering problems, and cannot be properly appreciated by persons who have not had a training in mathematics and mechanical science. The air literature may broadly divided into three sections—the superficially descriptive at a popular price, which can be readily understood, and probably serves to stimulate the interest of that enigmatic individual described as "the man in the street"; the semi-technical work, which aims at being a complete guide for the embryo pilot, giving him an elementary knowledge of principles; and the highly technical treatise written by the student and expert not so much for ordinary aviators as for engineers who are devoting their talents to the solution of flying problems and the evolution of a safe economical machine which will place aerial transport on a plane of real usefulness. The

book before us belongs to the second class, and it is written by an engineer who has had actual experience of flying.

The book, as its name implies, covers a very wide field. The first chapter is devoted to simple mechanics, and explains in clear fashion the theory of flight. Construction is considered in the next two chapters, while several chapters are devoted to engine design, and each unit is taken in turn and explained. It may give an indication of the attempted "completeness" of the book when we say that the last chapter is entitled "The Weather." The following quotation from the introduction is elucidating: "The aim throughout has been to enunciate fundamental principles, and to point the way to their development rather than to describe the actual practices ultimately resulting from them."

A book of beginnings, such as this is, is only complete in that it touches every phase of the subject. It has no right to the name of text-book, but it is interesting. Each chapter is a sign-post, and it is well that the specialist in one branch of a science should understand, even in a superficial way, the difficulties of workers in other sections. Mr. Bailey's book is profusely and very well illustrated by many line drawings and photographs, and these materially assist in making the book attractive. It is a book for a leisure hour.

CALVERT'S MECHANICS' ALMANACK FOR 1921. Manchester: John Heywood Ltd., Deansgate; 6d.

This well-known year book has now reached the forty-eighth year of publication, and has many features to recommend it, not only to mechanics, but to draughtsmen and others. It consists of 56 pages of tables and useful data. The more bulky and expensive year-books are very valuable to the engineer and mechanic, but they contain a great deal of matter which, while relevant, is seldom required. They are not exactly pocket-books, but Calvert's Almanack, by containing only essential information which is wanted day by day, and probably when the draughtsman or mechanic is at an outside job, and away from board or bench, is invaluable. A notable omission from this year's volume is the chronology of important events. The space thus made is usefully occupied by additional tables. The postal guide has been brought up to date, and included is a wages table for a 47-hour week.

PUBLICATIONS.

J. H. Sankey & Son Ltd.—This well-known firm of firebrick specialists have issued a Temperature Card. They state that the figures shown have been very carefully obtained, and while there is much diversity of opinion on the actual melting and freezing-points of some of the substances given, the figures should be sufficiently approximate to be useful.

Tuck & Blackmore Ltd., Coventry.—A catalogue of tools and engineers' supplies from centre-punches to drilling and shaping machines. It is certainly comprehensive. This firm is getting over the difficulty of fluctuating costs by issuing a separate price list every two or three months.

Higgs Bros., Birmingham.—November list of dynamos and motors.

Thornycroft's New Catalogue.—Messrs. John I. Thornycroft & Co. Ltd. have sent us a copy of their newly-issued catalogue of Thornycroft motor vehicles. It is an informative and artistic production, consisting of 48 pages, containing a wealth of information regarding the 2, 3, 4, and 5-ton models of Thornycroft vehicles the firm are now making. Commencing with a lengthy description of the technical features of the Thornycroft chassis, with illustrations of the most important parts, each model is dealt with separately with every item of information that a prospective buyer of a Thornycroft vehicle is likely to require when in doubt as to the exact model or type of body best suited for his particular purpose. An attractive feature of the catalogue is a series of illustrations in colour of different types of Thornycroft vehicles, and these are supplemented by views of each type of chassis and the many alternative types of vehicle bodies the firm supply. Readers contemplating the purchase of a motor vehicle should apply for a copy to Messrs. John I. Thornycroft & Co. Ltd., 10, Grosvenor Place, S.W.1, asking for catalogue No. 218.

New Companies.

Farndons Power and General Electrical Co. Ltd.—Private company. Registered Sept 25th. Capital £20,000 in £1 shares. To carry on the business indicated by the title, and to adopt an agreement with Farndons Electric Ltd. The first directors are: F. Farndon (managing director), P. Farndon, H. M. Watson, H. King, and T. J. Penney. The three first named are permanent. Qualification, £375. Secretary, F. G. Saw. Registered office, 32, Romford Road, Stratford, E.15.

Autyre Pumps Co. Ltd.—Private company. Registered Sept. 25th. Capital, 150 in £1 shares. To take over the business of manufacturers of pumps and motor engineers carried on by A. Fraser, C. E. Fraser, and C. A. Grossmith, at 14, Northwich Terrace Mews, Edgware Road, and Ulster Chambers, 168, Regent Street, W., as the "Auto Pumps Co." The first directors are: A. Fraser, C. E. Fraser, and C. A. Grossmith (secretary). Registered office, 168, Regent Street, W.

Steamship Appliances Ltd.—Private company. Registered Sept. 25th. Capital £1,000 in £1 shares. To carry on the business of agents, brokers, merchants, factors, and manufacturers in connection with shipping, engineering and general commerce. The first directors are: A. Esplen, M. Glasgow, and A. W. E. Davison. Registered Office: St. Mary's Chambers, 14-20, St. Mary Axe, E.C.

Rapid Mill Furnishing Co. Ltd.—Private company. Registered Sept. 24th. Capital, £10,000 in £1 shares. To take over the business of a mill furnisher, general dealer in mill stores and machinery, manufacturer of raw hide, raw hide hammers and mallets, carried on by J. A. Ashley, at 3, Allotment Street, Rochdale, as the "Rapid Mill Furnishing Co.," and to carry on the business of manufacturers of and dealers in mill stores, machinery, leather, balata, cotton, and hair belting, oils, fats, lubricants, etc. The first directors are: J. A. Ashley (managing director), H. Mallalieu, J.P., J. A. Turner, and W. S. Mallalieu. Solicitor: W. Street, 22, Brazennose Street, Manchester.

Breeze Slabs Ltd.—Private company. Registered Sept. 25th. Capital, £2,000 in £1 shares. To carry on the business of breeze slab manufacturers, builders' merchants, builders and contractors, founders, engineers, manufacturers of machinery, and to adopt an agreement with H. K. Bates, C. A. Watson, and J. N. Duncan. The first directors are: H. K. Bates, F. A. J. Poulson, and C. A. Watson. Registered office, B22, The Temple, Dale Street, Liverpool.

French Chains Ltd.— Private company. Registered Sept. 25th. Capital, £40,000 in £1 shares. To carry on the business of chain makers, engineers, founders, smiths, machinists, manufacturers, and patentees, etc., and to adopt an agreement with the Coventry Chain Co. Ltd. and Dubied et Cie. The first directors are: A. S. Hill (chairman), R. S. Cattanach, P. E. Dubied, and E. A. Dubied. Secretary, N. Hill. Registered office, 199, Piccadilly, W.

Gilberts Ltd.—Private company. Registered Sept. 23rd. Capital £2,000 in £1 shares. To carry on the business of manufacturers of electrical fittings of all kinds, art metal work and metal furnishings, coppersmiths, etc. The first directors are H. Davies, A. W. Green and W. C. McMillan. Qualification £5. Registered office, 15, Hillfield Park, Muswell Hill, N.10.

Diamond Engineering Co, Ltd.—Private company. Registered in Edinburgh, Sept. 23rd. Capital, £2,000 in £1 shares. To carry on the business of mechanical, electrical, motor, hydraulic, sanitary and general engineers, boilermakers, steel and brass founders, metal workers and general machine makers, etc. The first directors are: W. J. Rodgerson, D. W. Shaw and D. Veitch. Qualification, £400. Secretary, G. Meiklejohn. Registered office, Grahamston Station, Falkirk.

Mitchell, Shackleton & Co. Ltd.—Private company. Registered Nov. 10th. Capital, £200,000 in £1 shares (25,000 prefd.). To acquire the undertaking and all or any of the freefold and/or leasehold properties, assets and liabilities of Mitchell, Shackleton & Co. Ltd. (incorporated in 1907), and to carry on the business of metal workers and engineers, founders, smelters, makers of axles, cranks, girders, shafts, tubes, pipes, chains, boilers, lightning conductors, and iron and steel castings and forgings, electricians, electrical engineers, dealers in tanks, engines, motors and cranes, vehicle and motor makers, etc. The first directors are: Edwin Shackleton, Ernest Mitchell, and Kenneth S. Prescott (all permanent). Qualification, £100. Remuneration as fixed by the company. Registered office, Vulcan Works, Patricroft, Lancs.

Mortgages, Charges, Satisfactions.

Motor Vehicles (Engineering & Supply) Association Ltd.—Particulars of £21,000 debentures authorised July 16th, 1920, whole amount issued charged on the company's undertaking and property present and future.

Chipperfield Ltd.—Mortgage dated Sept. 20th, 1920, to secure £448 charged on certain land and buildings in Lowestoft. Holder, W. J. Croft, 4, Thurston Road, Lowestoft.

Century Drill Works Ltd.—Mortgage dated Sept. 17th, 1. to secure £3,500; charged on certain land and premises. Sheffield, and a Sinking Fund Policy. Holders, Legal and General Assurance Society.

Associated British Machine Tool Makers Ltd.—Land registry charge on 17, Grosvenor Gardens, S.W., dated Sept. 22nd, 1920, to secure all moneys due or to become due from company to National Provincial and Union Bank of England Ltd.

Lune Valley Engineering Co. Ltd.—Mortgage on certain freehold land in Meeting House Lane, Lancaster, and the company's undertaking and property, present and future, including uncalled capital, dated Sept. 18th, 1920, to secure all moneys due or to become due from company to Manchester and Liverpool District Banking Co. Ltd.

Premier Aluminium Castings Co. Ltd.—Particulars of £3,000 debentures, authorised Sept. 13th, 1920, whole amount issued; charged on the company's undertaking and property, present and future, including uncalled capital.

Straker-Squire Ltd.—Satisfaction in full on Aug. 6th, 1920, of mortgage dated Jan. 21st, 1920, securing £200,000.

Etchells, Congdon & Muir Ltd.—Debenture dated Oct. 26th, 1920, to secure £3,600, charged on company's undertaking and property, present and future. Holders, F. B. Cooker, 88, Great Ancoats Street, Manchester, and F. S. Kitchin, 43, Spring Gardens, Manchester.

Jones Bros. (Preston) Ltd.—Mortgage dated Nov. 8th, 1920, to secure all moneys due or to become due from company to London Joint City and Midland Bank Ltd., charged on certain properties in Bold Street, Preston.

Lamplugh Iron Ore Co. Ltd.—Satisfaction in full on Feb. 1st, 1916, of debentures dated May 22nd, 1913, securing £7,000.

Tilghman's Patent Sand Blast Co. Ltd.—Further charge on certain property at Broadheath, Altrincham, and Dunham Massey, dated Nov. 1st, 1920, to secure all moneys due or to become due from company to Lloyds Bank Ltd., not exceeding £100,000 in lieu of the limit of £32,000 fixed by mortgage dated Nov. 4th, 1912.

Seaton Carew Iron Co. Ltd.—Mortgage dated Nov. 3rd, 1920, to secure £19,432, charged on certain land and premises in Seaton Carew, Durham. Holders, S. Charlesworth, Sunnybank, Uffculm, Collumpton, Devon, and others.

Patent Applications.

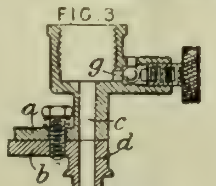
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

VALVES.

133,138.—BROWN AND BARLOW, Westwood Road, Witton, and C. BROWN, 19, Trinity Road, Birchfield, both in Birmingham.—Sept. 30th, 1918.—A rotary disc valve, particularly applicable for use in apparatus for measuring the flow of liquids, of the kind described in Specification 118,949, comprises a pair of discs *a b* eccentrically mounted with respect to the passageway *c*. The fixed disc is carried by the inlet branch, which is fitted with an air valve *g*, as described in the above-mentioned Specification,

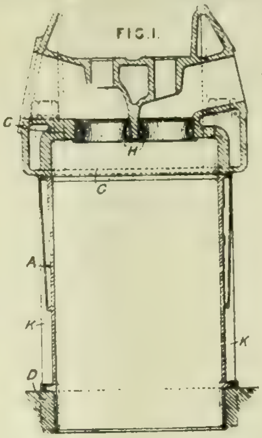
FIG. 3.



while the movable disc is formed integrally with the outlet nozzle *d*. Stops are formed on the peripheries of the discs. In a modified form, the seat is provided with inlet and outlet ports and is adapted to co-operate with a valve disc having corresponding ports joined by a pipe connection. Specification 121,015 also is referred to.

INTERNAL-COMBUSTION ENGINES.

132,848.—D. NAPIER AND SON, and A. J. ROWLEDGE, 211, Acton Vale, London.—Sept. 20th, 1918.—Steel cylinder barrels A are clamped between the crank case D and a head G common to two

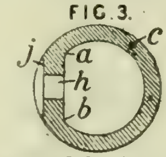


or more of them by long bolts K. The head is of aluminium or one of its alloys; it is water-cooled and carries the valves. The barrel is surrounded by a sheet-metal jacket.

STEAM SUPERHEATERS.

133,208.—W. E. ENGLISH, 4, Castle Square, Swansea, J. R. HANNAN, 51, Scarisbrick New Road, Southport, Lancashire, and C. H. MILLS, Callencroft, Mumbles, Glamorganshire.—Nov. 19th, 1918.—The header *c* is formed from drawn tube externally circular and internally circular except for a flat *a, b*, one end being closed

FIG. 3.



by forging and the other end having a flange for attachment to a junction box. Seatings *j* are formed to receive the ends of the superheating tubes and holes *h* bored through opposite each seating.

INDEX TO ADVERTISERS.

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— THE —

Industrial Engineer.

VOL. VIII.] DECEMBER 22, 1920. [No. 221.

The Industrial Engineer.

A PRACTICAL MAGAZINE FOR ENGINEERS AND POWER USERS.

Published twice monthly, on the 8th and 22nd days, respectively.

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EDITORIAL.

INCORPORATION.

THIS is the last of the *Industrial Engineer* in its present form, but it is not intended to let the spirit of this journal die. It is to be incorporated with the new and, it is hoped, more vital personality of the *Engineering World*. At the inception of the *Industrial Engineer* the policy agreed upon was one of a practical nature. It was decided that a great many engineers desired technical literature that could be readily assimilated, that was thoroughly practical in character, and comparatively short in composition. The many eulogies we have received from subscribers, the interest that has been taken in our efforts to supply a practical journal at a cheap rate, has induced us to make a further step forward in an endeavour to enlarge our field.

Originally it was intended to devote the *Industrial Engineer* to the discussion of matters relative to power producing and transmission, but it has been pointed out to us that we might usefully extend the scope of the journal, provided always that we did not depart from the extremely practical nature of our matter. To this end we have considered the whole situation, and propose, on January 8th, 1921, to publish the first issue of the *Engineering World*, a journal which it is hoped will be as welcome as the *Industrial Engineer* has apparently been.

It is our intention to make a particular feature of all matters relating to power, but it is also intended that we shall go further and provide a comprehensive engineering review that will be helpful to practising engineers engaged in any phase of the industry. Without endeavouring to cut our matter down to a minimum, we hope that excessive verbiage will not be a feature of the journal. Our arrangements are already made in regard to contributions, and it has been our main endeavour to secure writers who can impart the note of freshness to their articles. But—and again we must emphasise this point—we shall not be theoretical. Practicality is our motto, as it has been with the *Industrial Engineer*.

We think, therefore, it may be safely said that we are not burying the *Industrial Engineer*, but rather effecting a transmigration of all its good qualities to a new publication, and at the same time adding new qualities that will be of real practical value to our subcribers.

OIL-IMMERSED CONTROL GEAR FOR STARTING SQUIRREL-CAGE MOTORS.

By J. F. Foley.

Oil-immersed gear is considered suitable for installing in woodworking shops, flour mills and textile factories, where inflammable dust, fluff, etc., occurs, not forgetting collieries. Regarding "Coal Mine Regulation Act, 132" (*i.e.*, for fiery mines), where the percentage of gas is such that electricity is permitted, alternating current oil-immersed gear has no equal. The chief point of oil-immersion is that the contact making and breaking parts of the starter or switch are operating under oil, which precludes all possibility of any external gas becoming ignited. Sparking at the contacts is reduced to a minimum by the action of the oil in quenching the arc formed by alternating currents at the moment of zero potential, thus prolonging the life of the contacts and brushes.

With oil-immersed transformers the thermal capacity is gained by the volume of oil used, and the circulation of the oil materially assists in dissipating the heat that is generated in the transformer. To ensure efficient working it is essential that the operator should pay special attention to the supply of oil in the tanks and fill same to their standard level, which ought to be distinctly marked.

Star Delta Switches for Squirrel-Cage Motors.

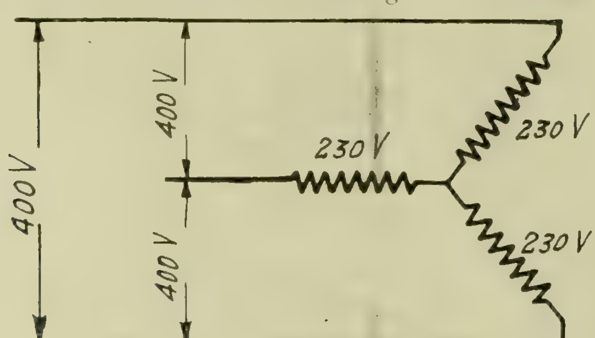
In starting up squirrel-cage motors where the starting conditions are light, such as when the motor is connected to a clutch, loose pulley or short length of shafting, the star delta switch is chiefly installed. The starting torque of the motor should not exceed 40 per cent of full load torque, approximately taking two and a half times full load current. For star delta starting, the above torque must not be exceeded, or otherwise the motor will not start up. The sizes of the motors usually range from 5 H.P. to 25 H.P., and in some cases higher. Below 5 H.P. size the standard practice is to instal a direct starter (change-over switch) and switching direct on the line.

The function of the star delta starter is in first connecting the stator winding of the motor in "star," and "delta" in the running position. When connected in "star" the voltage across the windings is less than the full voltage across the phases in the rates of 230 to 400 illustrated in Fig. 1.

The starter should be fitted with an interlocking and correct sequence device, so as to ensure that the operator moves the starter from the "off" to the "star" position prior to switching over to "delta" position. The drum type starter, fitted with finger tips and drum arcing contacts, are very good, owing to the latter being readily and cheaply renewable. It is essential for the switch to be of robust and mechanical construction, with all circuits broken under oil, and a release trigger should be fitted externally for returning the starter to the "off" position. It is wise to make the tripping of the overload coil operate independently of the no-volt release, although it may be mechanically connected to the same lever.

Two overload coils are sufficient protection in three-phase circuits, where the neutral is not connected to earth. In systems having a neutral earthed, it is essential that three overload coils should be fitted, one connected in each phase. For voltages up to 650 the no-volt coil is connected directly across two of the phases, and in the event of failure of the supply, the no-volt release should automatically open the circuit, thus tripping the switch.

Accommodation should be made for fixing trifurcating boxes, conduit glands, or conduit nipples. Three trifurcating boxes or glands will be necessary, the incoming box to receive the 3-core line cable and the other two boxes for the outgoing leads each consisting of 3-core cables to the motor. In the case of conduit fittings, three single core leads will be threaded through each of the two glands, making six leads in all to the motor. Trifurcating boxes should have preference to conduit glands for fiery mines.



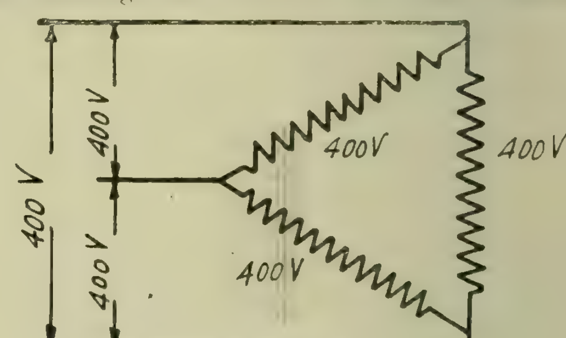


Fig 1.

Auto-Transformer Starter.

When the starting conditions of a squirrel-cage motor are severe or unknown (as is often the case with foreign orders), or when the local or supply authority places restriction on the value of the sudden starting current, the auto-transformers are best. An auto-transformer starter is preferable to a star delta starter, where it is desired to draw less current from the mains when switching on, or a larger starting torque is required; at the same time, to avoid a shock to the system, such as is entailed by switching the motor direct to the mains.

By the use of auto-starters, squirrel-cage motors can be started against full load torque, taking approximately three times full load current from the line, or against half full load torque, taking twice full load current. In starting, the motor is first connected to the line through the auto-transformer, which reduces the voltage initially impressed upon the motor and thus cut down the excess of current that otherwise would be drawn from the line,

while, owing to the transformer action, the line current is considerably less than the current in the stator windings of the motor.

The transformers should be amply rated and arranged with 4 or 5 tappings from the winding, preferably, 25, 40, 50, 60 and 75 per cent. In some cases 80 per cent tapping is requested instead of 75 per cent where a larger starting torque is desired. In the event of the motor not starting up on the lower tappings, adjustment can be readily made by connecting to a higher tapping, thus enabling the motor to start up. A 60 per cent tapping is equivalent to a transformer having a ratio 1/1·67, which is almost equivalent to that of a star delta starter. Whether an auto-transformer or star delta starter is used, the starting torque is proportional to the current drawn from the mains.

For smaller capacity auto-transformer starters up to 60 H.P. or 75 H.P. on 440 volt, 3-phase, 50-periods circuit, the combined oil switch and transformers are usually fitted in the one unit, the transformers being fixed at the bottom of the tank beneath the drum and operating gear. Some makers arrange the drum and operating gear to be fixed on the underside of the box cover, so that in the event of opening the latter, the renewable contacts may be easily replaced,

FIG. 2.

or the transformers tappings may be adjusted without interference with the drum or other mechanism.

The auto-starters should be designed to start up motors of their rated horse power against full load torque during a maximum period of 1 min. or 1½ min. in the starting position. The starting should be followed by a running or rest period of not less than 10 times the starting period respectively. If, however, the time required to start is, say, ½ min., then two starts may be made with 1 min. rated and three with 1½ min. rated during any 15 min. It is important to note that the horse power rating of the auto-starter must, in all cases, be equivalent to the full load horse of the motor.

For larger capacity starters, a triple pole, loose handle oil switch fitted with automatic features, mounted in a separate case, and bolted in combination with a non-automatic auto-transformer starter is used, and is mechanically or electrically interlocked. The function of the interlock is such that the operator must return the starter handle to the "off" position before closing the main switch. One recognised standard electrical interlock is to fit a no-volt no-close device on the switch and interlocking contacts on the auto-transformer starter.

Accommodation for time lag attachments should be allowed for on the main switch; this feature would have a retarding effect to prevent the overload coil from tripping the switch until the rush of current, due to starting a squirrel-cage motor, had passed away. For example, assume the switch is suitable for working on a coal cutter service. With a time limit attachment on the overload coil of the switch, the coal cutter may sometimes clear itself from a heavy fall of coal, the circuit remaining closed and the cutter in operation, whereas, if no time limit attachment were supplied, the overload trip would operate the switch, which might be some distance from the coal cutter working face, and would have to be thrown on again before work could be resumed. Another practice is to fit a small auxiliary lever on the side of the switch. The operator on moving this lever into the non-automatic position would cut out the overload attachment.

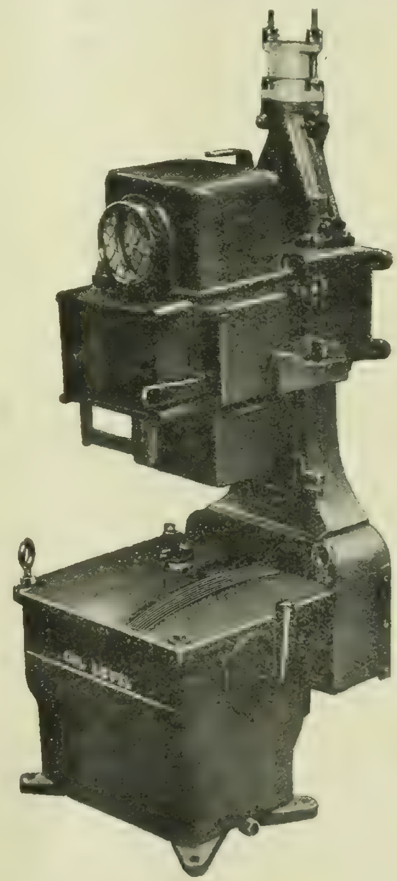


FIG. 3.

It is preferable for the side lever to be fitted with a spring return from the non-automatic to the "automatic" position, but the switch can be omitted for services where its inclusion would not be an advantage.

Where a switch is required to deal with a heavy momentary rush of current, and yet to retain the "spring return," a time limit attachment as described above should also be fitted.

Remarks regarding the number of overload coils apply for this combination pillar, as per specification already described in the star delta switch.

A typical combination panel suitable for use with squirrel-cage motors up to 100 H.P., 3-phase, 440 volt size, is depicted in Fig. 3. An ammeter of the 5 in. dial moving iron type fitted in an enclosed ironclad hood, and protected with wired glass inspection window, is also shown in this illustration.

THE "SILENT RECORD" ENGINE.

THIS engine, which is made by the Record Engineering Co. Ltd., is an interesting development in motor car engine practice. Many simple engines have from time to time been put before the public, but this engine, which has been developed over a considerable period, and is now somewhat largely used for stationary electric lighting and general industrial purposes, also motor boats, possesses some quite unique features. The aim of the designer has been to produce an engine which would, as nearly as possible, be of such substantial and simple construction as would enable it to run as silently and sweetly and with equal reliability as the well-known high-speed, self-lubricating steam engine, and from reports now obtainable of tests made, etc., this end would appear to have been attained.

The engine is practically noiseless in operation, and there are no poppet valves with their attendant tappets, springs, cam shafts, and gears, yet it is not unreliable, and the economical results are very good.

In the case of a Record two-crank engine, only one piston slide valve is necessary, this valve being operated by means of an eccentric formed solid with the crank shaft. This is the smallest type manufactured, and for four-crank and six-crank engines two and three valves respectively are required. There are no other valves on the engine, and as these valves are never subjected to the firing temperature and are only used to admit the working mixture to the engine, it is claimed that they never require attention or adjustment after test at the works, and have been known to work without attention for years at a time.

During the war, a number of engines of various sizes were supplied to the War Office, and in 1918 the Record Engineering Co. Ltd. were invited by the War Office to tender for a 40 B.H.P. paraffin engine which, before acceptance, was to run continuously on full load for five days and nights. The company confidently accepted this drastic condition, received the order, and in due course carried out this test under the direct supervision of the departments under the control of the Engineer-in-Chief (Admiralty), Director of Electrical Engineering (Admiralty), Director of Mechanical Engineering (War Office), and Chief Electrical Engineer (Air Ministry).

The engine ran not only five but for six days and nights, and during the whole of that severe endurance test it behaved perfectly without a stoppage of any description, even for a defective plug. The exhaust was colourless, and when the engine was opened up the cylinders were found to be free from deposit and the wear of the working parts infinitesimal.

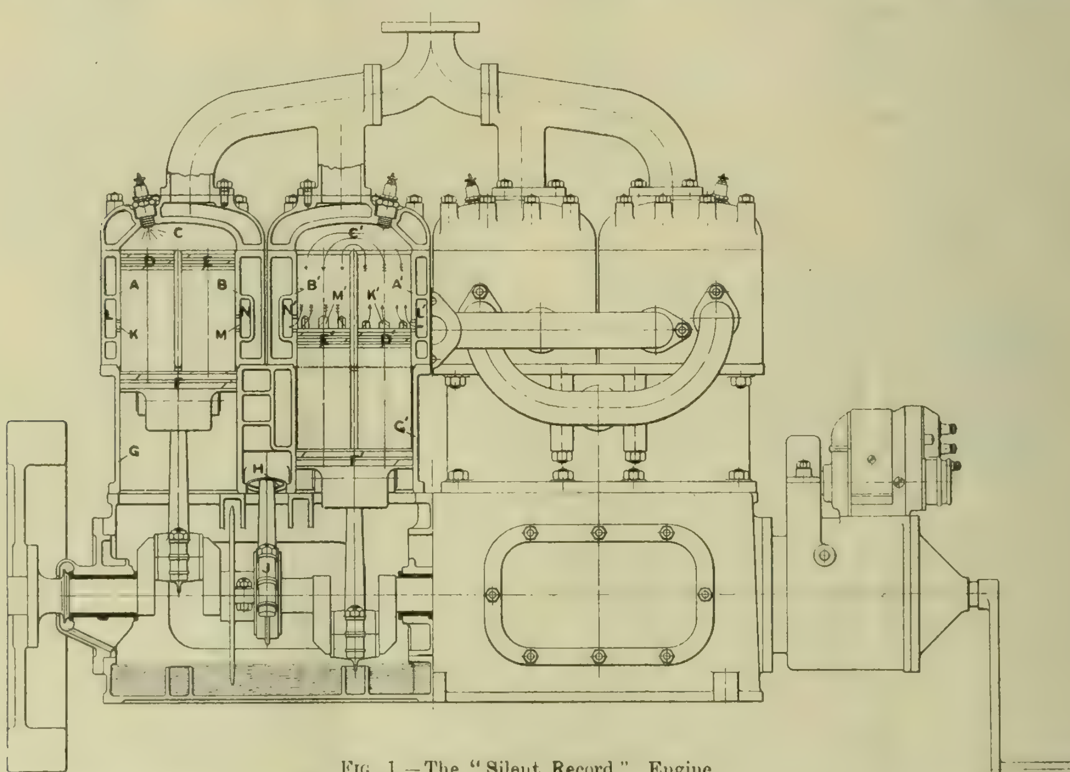


FIG. 1.—The "Silent Record" Engine.

The following extracts from a report received from the Air Ministry, London, are therefore very interesting at this juncture:—

144-Hour Continuous Load Run.

"The trials started at 1-15 p.m. on Monday, September 9th, and were continued without interruption until 1-15 p.m. on Sunday, September 15th, 1918, readings being taken at intervals of 30 minutes. The mechanical running of the engine was practically noiseless, due to the absence of exposed tappets and valves, and the absence of vibration was very noticeable, which will be observed by the sharpness of definition of the cylinders in the attached photographs which had two minute exposure. The engine was fitted with a system of forced lubrication, and a water circulating arrangement of good design, which gave no trouble during the period of the test, viz: 144 hours.

"After the trial, one of the cylinder covers was taken off to ascertain the amount of deposit resulting from the conditions of the trial. The absence of deposit was remarkable, and it is considered that this engine would have run another week continuously without giving trouble."

It will thus be seen that the engine we are describing is not of the mushroom development, but various designs have been gradually built up—first for stationary work and industrial purposes, secondly for motor boats, and finally for motor cars. In the four-cylinder type the cylinders are all cast in one piece, and have a loose cylinder head, this being a feature adopted by the Record Engineering Co. long before the first loose cylinder head was introduced for motor car work.

The pumping pistons, it will be noticed, practically act as crossheads for the conecting rod, and, as is perfectly obvious, they are never subjected to any high temperature, consequently they can be made an exceedingly good fit, and even these pistons are never

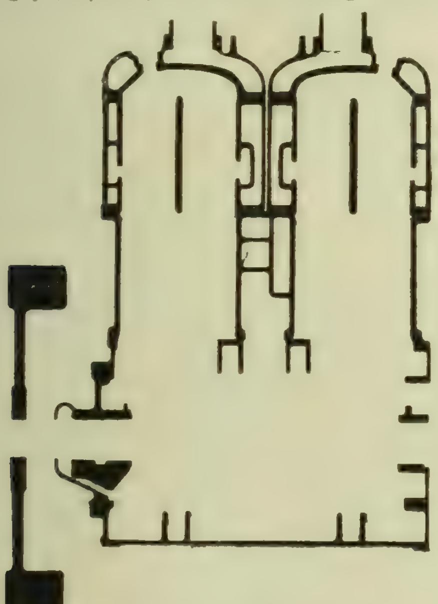


Fig. 2.—The "Silent Record" Engine.

subjected to what is called "slap." The working pistons are rigidly fixed to the top of the pumping pistons, and consequently reciprocate up and down in their cylinders without the slightest pressure being put upon the walls of same, other than by the piston rings they contain. From this it will be seen that the pistons work under ideal conditions. The engine exhibited is fitted with forced lubrication to all working parts, the pump being of the valveless type, driven directly from the eccentric strap which operates the piston slide valve.

A point here should be specially noted with reference to the piston slide valve. In the ordinary poppet or sleeve valve engine, if leakage takes place at all, it soon becomes a serious matter, because it is subject to the maximum pressures contained in the cylinder, possibly 250 lbs. per square inch. In the Record engine the piston valve has only to retain the pressure of the pumping cylinder, which never exceeds 10 lbs. per square inch, consequently the work required of the one is out of all comparison with that of the other. In the first case, the valve is absolutely cool, beautifully lubricated and under scarcely any pressure, whereas in the second case the valve is roasted and has to withstand a pressure of something like 250 lbs. per square inch as above stated, otherwise the efficiency of the engine falls off.

In this connection it is contended that it is possible in a Record engine to maintain the efficiency for extremely long periods, and the efficiency of an engine after running 144 hours continuously night and day, fully loaded, is, if anything, superior to what it was at first. This can hardly be obtained with ordinary poppet valve engines.

In this engine the mixture is drawn through the carburetter (or mixing valve in the case of gas engines) and delivered to the working cylinders by means of the charging pumps (cylinders G, G^1 and pistons F, F^1—see Fig. 1. The cycle of operations will be better understood if only one pair of working cylinders are considered. As the charging piston F moves downwards in cylinder G it draws a supply of mixture through the piston valve H. During the upstroke the mixture is slightly compressed and is delivered to the inlet cavity L which surrounds the working cylinder A and is always in communication with the ring of inlet

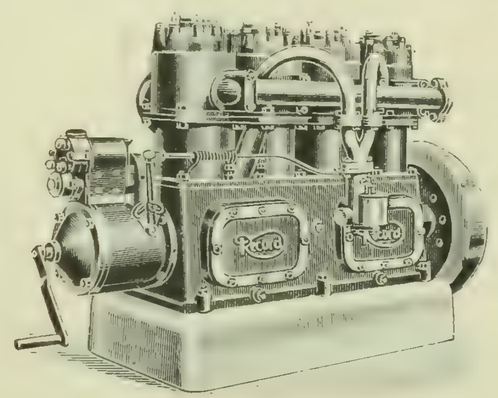


Fig. 3—The "Silent Record" Engine.

ports K. Assuming that the charge has been compressed and fired, pistons D and E will be forced downwards. When they are nearing the bottom of the stroke, piston E commences to uncover the ring of exhaust ports M which surround cylinder B, and the burnt gases flow out through cavity N to exhaust pipe. Immediately afterwards piston D uncovers the ring of inlet ports K around cylinder A and the partially compressed mixture in cavity L flows in, filling in turn cylinder A, combustion chamber C, and cylinder B, and driving out the remaining burnt gases through the ports M which close just in time to prevent loss of fuel. This operation is clearly shown in cylinders B^1, A^1. The working pistons D E then rise and compress the charge when it is again fired.

The productions of the company are of a wide range. For stationary, electric lighting and industrial purposes engines are manufactured in powers ranging from 1½ to 150 B.H.P., and these engines are suitable for working on petrol, paraffin, or gas. Engine of similar sizes are also being built for motor boats, and the motor car engine will undoubtedly now be very rapidly developed, owing to its absolute silence in operation and the simplicity of its parts.

LOUD-SPEAKING DEVICE REVOLUTIONISES SHIP COMMUNICATIONS.

Announcement was made by the Western Electric Co., New York, recently, that for the first time in the history of vocal transmission, direct communication had been made with an outgoing steamer without the aid of any receiving apparatus. The experiment which was made when the Cunard liner Imperator sailed for Europe recently, was pronounced a decided success by R. L. Jones, transmission engineer, of the Western Electric Co. and his co-worker, R. C. Mathes, in a cable from England.

The passengers on the former German liner were amazed as they sailed down the North River and towards the Narrows to hear a deep penetrating voice boom out from nowhere, "Steamship Imperator, ahoy! Paging Mr. Jones, Mr. Mathes." The call, which was repeated several times, might have been that of a New York bellboy. There was only one difference—it was intelligible. Immediately all sorts of rumours began to circulate. Some folks with guilty consciences wondered if they had already passed the three mile limit. There was one thing certain. Some voice was coming out of the heavens, and it was not paying any attention to the cries of the sailors, the tooting of the tugs, or the chattering of the departing voyagers.

The only one on board who did not seem to show any wonder at the phenomenon was Dr. S. W. Stratton, Director of the United States Bureau of Standards. He cocked his ear, listened, and smiled. He had seen the imagination of Jules Verne and H. G. Wells outdone in the developments of the war-racked world during the last few years.

Seemingly having located Mr. Jones and Mr. Mathes, the giant voice changed its bell-hop chant. "Bon voyage, Mr. Mathes. We hope your trip will be very pleasant. Just a minute now and we will play you something," and in the same mystic fashion the sweet and clear notes of "It's Apple Blossom Time in Normandy" drifted over the ship.

"Good Lord," shouted the pilot, "I'm about to pile this ship upon the rocks of some cabaret."

Before the scared mariner could carry out his threat, however, Mr. Jones explained to the scores of his fellow passengers who had collected in curious groups, that it was only his colleagues bidding him farewell from the Western Electric Laboratories at West Street. The "giant voice" was coming from one of the loud-speaking transmitters which was developed by the Western Electric engineers, and which had been set up in the window of Mr. Jones' office on the tenth floor. Amplified a million times, the voice of one of the engineers had carried distinctly to the passengers on the Imperator above the din of New York's busy waterfront.

The loud-speaker has never been tried before under such adverse conditions. The success of the experiment only forecasts other remarkable achievements for it.

"Imagine some politician returning from abroad talking to assemblages in 10 halls in 10 different cities from a ship 600 miles at sea, with the aid of the radio telephone and loud speakers," commented one of the engineers.

And it is very probable that with the rapid development of the "giant voice" this may be done.

SHIPBUILDING IN CANADA.

A good idea of the importance of the Canadian shipbuilding industry is to be obtained from glancing at the particulars of the large number of ships now in the various services of the Canadian Government or the Canadian Government Merchant Marine Limited. All were built in Canadian shipyards. We find that, besides the Canadian Victor, a number of the larger ships in the fleet were also built by the Canadian Vickers firm, such as the Canadian Conqueror, of 5,400 tons gross, constructed this year, and the Canadian Navigator, of rather over 3,000 tons, completed last year. Among the larger ships are also the Canadian Explorer, of 5,700 tons, built this year by the Halifax Shipyards Limited, at Halifax, N.S.; the Canadian Exporter, of 5,500 tons, built this year by Messrs. J. Coughlan and Sons at Vancouver, B.C., and the Canadian Importer, of similar size, built also this year by the same firm. Two of the largest ships in the fleet are the Canadian Reaper and Canadian Thrasher, of nearly 5,500 tons gross each, built by the Prince Rupert Dry Dock and Engineering Company at Prince Rupert, in North British Columbia. The Canadian Trooper, of nearly 3,200 tons, was constructed by the Wallace Shipyards Limited, at Vancouver. The Canadian Armourer, of nearly 5,500 tons, was completed by the Harbour Marine Company Limited, at Victoria, B. C. The Tidewater Shipbuilders Limited, Three Rivers, P.Q., were responsible for the Canadian Fisher, of 3,500 tons, and, the Davies Shipping and Repairing Company, of Levis, P.Q., for the Canadian Trapper, of 3,300 tons.

Construction on the Great Lakes.

Among the smaller vessels we find a number built on the Great Lakes, such as the Canadian Adventurer of 2,000 tons, by the Port Arthur Shipbuilding Company, of Port Arthur, Ontario; the Canadian Artificer, of 2,400 tons, by the Dominion Shipbuilding Company of Toronto; the Canadian Warrior, of 2,400 tons, by the Collingwood Shipbuilding Company, of Collingwood, Ontario; and the Canadian Otter, of 2,800 tons, by the British-American Shipbuilding Company, of Welland, Ontario. But not all the smaller vessels have been built on the Lakes. The Canadian Sealer, of 1,700 tons, was built by the Nova Scotia Steel and Coal Company Limited, of New Glasgow, N.S. The mere narration of the names of these ships and their builders gives a picture of a widespread shipbuilding industry in the Atlantic Provinces, on the Canadian shores of the Great Lakes, and on the coast of British Columbia bordering the Pacific Ocean.

Widespread as the shipbuilding industry in Canada now is, it owes its present development to the impetus of the great war. Before the need for tonnage to replace losses became insistent, ship construction in Canada was comparatively insignificant. Shipbuilding in Canada during the war could not rival the extraordinary development of the industry in the United States, but it has to be remembered that Canada, which had been in the war from the outset, had not a tithe of the men upon whom the United States could call. Shipbuilding in the United States was officially and fully recognised as one of the great contributions which the country was making to its participation in the war. It received

every possible encouragement from the Government. Canadian shipbuilding was handicapped, not only by lack of men, but in other ways as well. No campaign of national service and enthusiasm for shipbuilding was conducted there, or probably was practicable. The Canadian yards had, to a large extent, to rely on steel from the United States mills. Thus the Vancouver yards drew large portions of their supplies from steel mills in the Eastern States some 3,000 miles away. Yet the assistance which the one country gave to the other was not entirely one-sided. Marine engines were built by works at Toronto, and in its neighbourhood, for United States yards on the Pacific Coast, notably at Seattle. This was especially the case with the wooden steamers, which were produced in great numbers in the States of Washington and Oregon on the Pacific Coast. The trouble with the wooden-ship programme was to supply the engines. The construction of the hulls was, as a rule, ahead of the building of the marine engines.

Wooden Ship Epidemic.

At a time when ships of any kind were wanted Canada did not escape participation in the epidemic of wooden-ship construction. In the early part of 1918 there were a number of wooden-ship yards actively at work in British Columbia. Gradually, as the production of steel ships became recognised as a prime necessity and the output of Great Britain and the United States steadily increased, work in these wooden-ship yards died down.

One of the yards which, it will be seen, has been constructing the larger type of steel steamers was entirely a war development. Messrs. Coughlan's were well known at Vancouver as constructional steel engineers. They had been established there for 40 years and had built many of the chief city offices. They started to build their first slipway in November, 1916. The first keel was laid in February, 1917, but the first consignment of steel of any magnitude did not reach the yard until May, 1917, and the first vessel was not launched until January, 1918. Since then much quicker work has been done. This yard is a complete one, with equipment for building engines and all parts of a ship.

The Wallace Shipyards, Limited, was the pioneer steel-ship yard in Vancouver. It was founded and has since been controlled by Mr. Alfred Wallace, a native of Brixham, Devon, who went to Canada 33 years ago and began building in large numbers a small type of salmon fishing boat. In the earlier part of the year his firm built a number of wooden schooners. Later three slipways were constructed for steel steamers.

Repairing Plant.

An important undertaking at Esquimalt, near Victoria, B.C., is owned by Yarrow's Limited, a subsidiary of Yarrow and Co. Limited, of the Clyde. This firm has a ship-repairing yard at Lang's Cove, adjoining the Government dry-dock, and has concentrated on the repairing of shipping on the Pacific coast. During the war it built a number of shallow-draught vessels which were shipped to India. It owns a marine railway capable of accommodating vessels of a maximum length of 313 ft. and displacement of 2,500 tons. The Vancouver shipyards have to their credit the training of many men who afterwards left to occupy good positions in the United States yards on the Pacific coast.

There are at present limits set to the construction of ships in Canada, for the liner Empress of Canada, the latest of the great vessels to have been constructed for the Canadian Pacific Railway Company, is now fitting out at Fairfield Yard, on the Clyde. The Empress of Canada is of 22,000 tons gross and is the largest merchant ship to have been launched since the Armistice. Yet it is notable that the contract has been placed with a Vancouver shipyard for the construction of a passenger and mail steamer to take a place in the Pacific coast passages among the fine class of "Princess" ships. Hitherto all these ships have been built on the Clyde, and the new contract seems to indicate a stage in progress of the Canadian shipbuilding industry. It is notable that, speaking at Vancouver recently, the Hon. C. C. Ballantyne, the Dominion Minister of Marine, declared that ships in Canada were being built at from 25 dols. to 100 dols. per ton less than the ships in the United States, and he maintained that they were "much better built." Canada, he added, has now 17 shipyards. There is no doubt that she realises the great value of a large mercantile marine, as is indicated by the services she has recently inaugurated between the ports of the Atlantic and Pacific provinces and various ports throughout the world, and especially as she is able to develop her iron and steel resources and keep the cost of construction within moderate limits, there should be a good deal of work available for her new and important shipyards.—*Times Trade Supplement*.

MANNING THE OIL-FIRING STOKEHOLD.

Mr. Charles McVey, Mersey district secretary of the National Union of Sailors and Firemen; Mr. James Henson, Bristol Channel district secretary; and Mr. A. O'Fallon, an independent engineer, have just completed a round trip to New York in order to test from a trade union standpoint the working conditions in the stokehold of Atlantic liners equipped as oil-fuel burners. From their experience it is hoped to avoid future friction with regard to the manning of the stokehold.

When the Cunard liner Aquitania and the White Star liner Olympic were reconditioned for oil fuel last summer there were disputes with the union as to the number of firemen to be engaged, the companies proposing that one fireman should look after not less than twelve oil fires, whilst the men through the union stood out for nine fires per man. The companies gave way for the time being, and made the arrangement that the three delegates should make a voyage in order to see for themselves how things worked.

Mr. McVey, in an interview recently, said the deputation spent seven or eight hours a day in the stokehold witnessing the actual conditions of work. He declined to say what effect their experience would have in deciding the number of fires each fireman should look after, as they had to report to the Executive of the Union, but he said the work is now more technical and skilled and requires more careful attention than was the case with coal fires. The laborious and dirty nature of the work has gone, and the stokehold is much cooler. The large displacement of labour is serious, however, and to assist in helping the solution of this problem Mr. McVey suggests a 48-hour week at sea.

POWERFUL WIRELESS STATION FOR BELGIUM.

The administration of posts, telegraphs and telephones announces that contracts may now be submitted for the building of an inter-continental wireless station, which it is intended to make one of the most powerful in the world. It is intended that the Belgian transmitting station shall be in permanent communication throughout the 24 hours with the powerful American stations, while a 12-hour service is to be maintained to the Argentine, and an eight-hour service to the Congo, the latter service being necessarily of shorter duration by reason of the adverse atmospheric conditions which prevail in equatorial regions during the greater part of the day. Belgium is some 3,750 miles from the United States and from the Congo, and about 6,875 miles from Argentina. The transmission of 1,800,000 words per month is to be provided for—that is, an average of 60,000 a day, divided as follows, 35,000 to the United States, 10,000 to South America, and 15,000 to the Congo.

For such a powerful station, considerable force will be necessary, probably 750 to 1,000 kilowatts, which will either be furnished by a special power station or drawn from one or two distributing stations already in existence which may be able to supply the necessary current. The antennae will be of vast dimensions and will be supported by eight steel pylons, each 250 metres in height; that is, only 50 metres less than the Eiffel tower. The antennae and the surrounding buildings will occupy a space of about 250 acres. For various reasons of capital importance, the station is to be erected in Flanders. The apparatus will be able to receive messages of widely varying wave lengths, and a service in both directions will be able to be maintained at the same time, the receiving station being in no way hindered by the powerful transmitting station a few hundred yards away. It is morever intended to construct a multiple transmitting station so that messages may be sent simultaneously to the United States, Argentina, and the Congo. Thus the new station should be both economical and of very real value, especially for commercial purposes.—Reuter.

AN interesting afternoon was spent by the King's College Engineering Society on Wednesday, 8th December, when the members visited the works of Automatic & Electric Furnaces Ltd., 281/283, Grays Inn Road, and witnessed demonstrations of the Wild-Barfield automatic steel-hardening furnaces.

SUBSTITUTE FUELS.—The Commercial Counsellor to His Majesty's Embassy in Washington, commenting on the U.S.A. Press reports relative to the production of gas and motor fuel for lighting and power purposes from straw, states that the apparatus for this purpose which was exhibited at the Chemical Exposition in New York City in the Autumn of 1918, is apparently simple and easily manageable, and consists of an oven 4 ft. wide by 10 ft. long and 6 ft. high, a steel retort 18 in. in diameter and 5 ft. high, and a steel reservoir 7 ft. high and 6 in. diameter. The pressure on the walls of the retort and the tank is about 35 lbs. to the inch. The aim of the invention is simply to make it possible for the farmer in the grain growing districts in the west to make on his own farm fuel for running his machinery and light for his buildings. It is not expected to compete outside these districts with ordinarily produced fuel. According to the *Journal of Commerce* of 5th October, a company has been formed in North Dakota to manufacture and install plants for straw gas.

STEAM ACTION IN SIMPLE NOZZLES.*

By A. L. MELLANBY, D.Sc. AND W. KERR, A.R.T.C.

THE authors give an exposition of a simple method of dealing with variants in "straight" nozzle expansion. The problem of the expansion of a fluid through a nozzle is one of outstanding practical importance and of great theoretical interest.

Consideration of the main difficulties in nozzle flow can only be achieved by a study of the internal jet conditions which result from the varying boundary and fluid conditions imposed.

In taking a general view of the extensive experimental work on this subject the observer is struck by the restriction of method in the more comprehensive researches to one, or a combination of two, out of three main methods. These methods are:—Determination of flow, of reaction, and of impact. In addition, some experiments have been made by the "search tube" method, in which the pressure fall along the jet is observed. These are, however, of minor extent, and have only resulted in more or less confusing curves of pressure variation. Of flow measurements little more can be said than that they determine the flow in the individual cases examined.

Reaction determinations would seem to be of distinct value in arriving at total efficiencies of expansion. The method, however, provides "overall" information only, and fails entirely to give any indication of internal effects. It might be imagined that comprehensive research of this type could determine the influence of, say, entry curve on the expansion by dealing with nozzles having this as a variable factor of form. But this is not so, since change of entry could, and may, alter the conditions of flow in the following parts, and the result, as obtained, would only show the balance of change. Again, the reaction effects are usually based on the expansion ratio of exhaust and supply pressures, but it is by no means certain that the range of the actual nozzle operations, on which the reaction depends, is in exact agreement therewith. It would seem necessary to accompany this determination with a measurement of the exact action range of the nozzle itself.

The measurement of impact effect is probably of use for direct application to turbine work, but as a method of pure research on nozzles it is hardly satisfactory. Like the reaction method, it is of the "overall" type, but it has the additional demerit that it includes in its consideration any occurrence beyond the nozzle mouth, since the impact plate cannot be made coincident with the outlet.

Both reaction and impact processes are methods of search for the jet energy.

All things considered, the impact method seems less sound than the reaction as an examination of the expansion efficiency of the nozzle itself. Detailed observation of the action in the free space would be necessary to relate the two different results, and since this may be affected by various accidental factors, it is unlikely that the relationship would be finite and general.

The "search tube" method is entirely one of internal examination, but it only serves to determine one of the factors involved, and is, therefore, of itself insufficient. But it would seem necessary to believe

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* Abstract of paper read before the Engineering Section of the British Association

that some such process should be an essential part of a nozzle research scheme. This pressure measurement is the simplest of the "internal" methods. Temperature observations are troublesome to obtain, and are, perhaps, less valuable, while velocity or density determinations present many difficulties.

It has seemed desirable to discover how much information could be extracted from experiments combining the simplest of the "internal" methods with the simplest of the "overall" methods, *i.e.*, "pressure-flow" experiments. No doubt further combination with the reaction method would be still more valuable, but this would lead to complications rather undesirable at first, and, indeed, such developments could afford to wait the demonstration of their necessity.

The present paper outlines the method of analysis, and discusses general points arising therefrom.

The point universally recognised in nozzle action is the existence of a critical pressure, imposing a definite throat condition and minimum cross section for maximum flow. The ratio of this pressure to the pressure of supply is readily evolved from the equations of perfect expansion, being ·546 for superheated (or supersaturated) steam, and approximately ·58 for wet steam. Of course, the actual expansion is imperfect, but this is not customarily supposed to affect the throat condition to any appreciable degree.

Now it has to be realised that the flow of a gas into and through a nozzle is liable to adventitious influences arising anywhere in the jet length. Thus, too fine an entry, too quick a curve, too large a throat, a wire edge, inconvenient path of approach, errors in the divergence and faults on the boundary surfaces would all have their due effects at the points where they occur; and these effects would have their influence on the actual flow, on the jet form, and on the expansion law.

A constant efficiency is an unlikely condition in nozzle expansion, since the potential value of a fault in nozzle form, area or finish is manifestly dependent on its position. The conclusion is, therefore, reached that in order to study possible variations in the internal conditions of a jet, any kind of expansion must be envisaged, and a special form relegated to its proper place as merely one type, and not as a permissible approximation to all types. Consequently it is desirable to develop a simple method capable of embracing widely different expansion types.

A series of quotations is given in the complete paper from which to obtain the desired method of calculating expansion for various types of nozzles, and conditions to be observed in the study of particular forms are laid down.

A.E.S.D. (York Technical Section).—Much interest was evinced in the paper, "Gear Tooth Forms," read by Mr. E. W. Tipple, Leeds, before the York members of the A.E.S.D. Lantern slides helped the author in explaining the principle of power transmission in the early ages, outlining the difficulties which have had to be overcome in the production of the modern high-class gears. The involute and cycloidal forms of teeth, and their generation, were described and demonstrated by working models, the advantages of helical teeth being enumerated. The lecture concluded with the various applications of high-speed gearing, and an interesting description of modern gear generating machines.

ELECTRIC POWER IN JAPAN.

Arguments in Favour of Nationalisation.

The capital involved in the electric industry of Japan, says the "Asahi," amounts to some 1,100,000,000 yen. Gas and steam power industries are stationary, but the electric industry has developed rapidly until it now occupies a most important position in relation to the country's productive industries.

The present prosperity of the electric industry in this country is due to private enterprise. There are few municipal undertakings and they are all on a small scale.

The future development of the industry is a serious national question. At present electrical enterprises are inadequate to meet the actual demand, and signs of further development are wanting, one reason being that the companies enjoy too much of a monopoly and are therefore unwilling to take any risks.

The amount of capital that will be required yearly hereafter will not fall below 100,000,000 yen, but few Japanese capitalists are willing to invest money unless they are guaranteed a dividend of over 12 per cent. Further, no success has attended the introduction of foreign capital, as may be proved by the record of those companies that have made the attempt.

The price of electricity in Japan is not higher than in other countries, but it must be noted that whereas abroad, in England, Germany, Italy, Sweden, Norway and Switzerland, for instance, a great effort is being made to reform the industries for the main purpose of reducing the price of electricity to the lowest possible figure so as to encourage productive industry, in Japan nothing of the sort is being done, and it is likely that she will become the dearest country in the world for electricity.

Other evils arise from the monopolistic character of Japan's electric industry. Many companies are criticised for the frequent interruptions of current and for dilatoriness in making the necessary repairs.

The Government railway business is one of the most progressive undertakings of the country, but it depends on coal, and the Japanese railway authorities have been remarkably slow in awakening to the necessity of using electric power. The railway department, it is true, presented in the last session of the Imperial Diet a Bill for the electrification of the State railways, but it was shelved. The Government estimates that the amount of electric power necessary for the railways could only be obtained from a Government undertaking as the existing companies would be quite unable to supply it. This plainly proves the inadequacy of the private ownership principle hitherto adopted by Japan, and shows how necessary it is to reform the industry. Such being the case, it appears that there is no alternative to nationalisation.

Again, the industrial system of Japan has grown so rapidly that there are a great many spinning mills, mines, chemical works and other factories in different part of the country. The owners are greatly troubled and inconvenienced by the differences in the prices of electric power and the cost of installation. At present it is impossible to standardise these things, and the only hope is nationalisation.

Japan's electric industry is principally run by means of water power and the employment of this power will grow. The water power available is considerable, but the methods now adopted by private companies are imperfect and extravagant for the most part. Furthermore, there is such keen competition among the applicants for water power rights that they are often secured merely for speculative purposes and without any intention of using them. Of the estimated unused water power capacity, more than 3,000,000 H.P. has already been granted to private concerns, but it is doubtful if the holders of these rights will start work within the next ten years.

This is a further argument in favour of nationalisation, though it would perhaps be inadvisable to go further than a nationalisation of the system of generating and transmitting power. Into all this the question of money enters, but it should not be difficult to raise the necessary funds by a foreign or domestic loan at a moderate rate of interest.—Reuter.

IRON FOUNDRY CLEANING ROOM EFFICIENCY.

By L. M. Krull.

The grinding wheel plays such an important part in the foundry cleaning room that it is well worth considering how this tool can be used most efficiently. Since labour and overhead are the two important items to observe with an aim towards their reduction per unit of product, it is necessary to follow the process in the foundry from the beginning with this in mind. Consider overhead and labour as the two important cost items in a cast-iron cleaning room, because carbide of silicon wheels, which are used for snagging the castings, have a comparatively long life, and therefore the wheel cost per unit of product is very small compared with the labour and overhead for the same unit.

Preparation of Casting Prior to Grinding.

The amount of grinding to be done on a casting is exactly in proportion to the excess metal left, after the gates and fins have been knocked off. A bad practice in making gates in the mould results in excessive grinding. Often it is necessary to have a hammer at the grinding-wheel stand so that these projections can be knocked off. This requires time and time is money. Where it is possible and feasible, the gates should be moulded instead of hand cut. In either case the gate should so taper that it will break off near the casting. Broad thin gates break better than thicker and narrower ones.

Tumbling is the cheapest method of removing the sand from the general run of castings. In addition many fins and gates are knocked off in this operation.

Method of Handling.

More important than the above mentioned points to observe is the method of handling the casting. The object here is to keep the wheels of the grinding stand in contact with the castings for as much of the day's time as possible. The time spent in getting a casting to the grinding wheel and properly disposing of it after grinding, should be kept at a minimum. This can be brought about by proper arrangement of machines and a good system of trucking. The castings should be arranged in three groups—heavy, medium, and light. Large heavy castings are ground by means of swing-frame machines, or portable grinding machines. These machines should be placed in easy reach of the crane. All castings which can be readily handled—that is, from 1½ lb. to 60 lb.—should be snagged on floor stands. Castings smaller than 1½ lb. are more economically ground on bench stands.

The feeding of the castings to the grinding machines and the removal of the finished pieces without interruptions and interferences so that the work can be kept going continuously are the first considerations. To effect this, the castings must be placed within easy reach so that the operator can grasp them with one hand and deposit them into a container with the other hand, without turning the body excessively. This, of course, applies to the small and medium castings only.

Bench stands can be arranged along a wall upon solid benches, and placed as shown in the sketch. The small castings are easily shovelled into the bins at the side of each wheel. The grinder is then in a position to handle them most rapidly—depositing the finished pieces into small kegs or boxes which stand on the floor beside him and which the truckman can readily take away.

Floor stands are best arranged in a line at a sufficient distance from any wall or other machines so that the boxes of castings can be fed to them from one side and taken away at the other with ample room for the truck.

A good box for the floor-stand castings is one about 3 ft. by 4 ft. mounted upon two 12 in. diameter wheels at the centre and 3 in. casters on each corner, which will clear the floor by ½ in. when the box is level. Such a box can be readily shifted about by the operators, and also bodily lifted by an electric lift truck, or pulled about by a tractor.

The Grinding Wheel and Machine.

Is it because grinding costs are seldom placed under observation that so little thought is given to the grinding equipment The greatest success of any machine is in its running free from vibration. Vibration in a turbine or gas motor is highly detrimental. In other types it is bad because it hastens depreciation and increases cost of repairs. In a grinding stand it does several things. First, it aggravates the operator, makes him dissatisfied, and tires him. Second, it wears away the grinding wheel because of the continual hammering, and tends to make it constantly out of round. The operator then trues the wheel to remedy this condition, thereby again wasting wheel material. Third, depreciation and repair items become alarmingly great. This is not mere theorising. Many cases of increased wheel wear could be cited. Only recently one came under our observation. In one foundry where the machine equipment was very light, poorly mounted, and in bad condition with regard to bearings the wheel wear was 1·13 cubic inches per hour. In another, where the wheels were mounted on medium-heavy machines, and rather well kept, but using the same wheel as to size, grain, and grade, the abrasive consumption was only 0·58 cubic inch per hour, or one-half the amount. In

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 106 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 1 24	0 18 3 20	1 8 1 16	1 17 3 12	2 7 1 8	2 16 3 4	3 6 1 0	3 15 2 24	4 5 0 20	0
1	0 3 22	10 1 18	0 19 3 14	1 9 1 10	1 18 3 6	2 8 1 2	2 17 2 26	3 7 0 22	3 16 2 18	4 6 0 14	1
2	1 3 16	11 1 12	1 0 3 8	1 10 1 4	1 19 3 0	2 9 0 24	2 18 2 20	3 8 0 16	3 17 2 12	4 7 0 8	2
3	2 3 10	12 1 6	1 1 3 2	1 11 0 26	2 0 2 22	2 10 0 18	2 19 2 14	3 9 0 10	3 18 2 6	4 8 0 2	3
4	3 3 4	13 1 0	1 2 2 24	1 12 0 20	2 1 2 16	2 11 0 12	3 0 2 8	3 10 0 4	3 19 2 0	4 8 3 24	4
5	4 2 26	14 0 22	1 3 2 18	1 13 0 14	2 2 2 10	2 12 0 6	3 1 2 2	3 10 3 26	4 0 1 22	4 9 3 18	5
6	5 2 20	15 0 16	1 4 2 12	1 14 0 8	2 3 2 4	2 13 0 0	3 2 1 24	3 11 3 20	4 1 1 16	4 10 3 12	6
7	6 2 14	16 0 10	1 5 2 6	1 15 0 2	2 4 1 26	2 13 3 22	3 3 1 18	3 12 3 14	4 2 1 10	4 11 3 6	7
8	7 2 8	17 0 4	1 6 2 0	1 15 3 24	2 5 1 20	2 14 3 16	3 4 1 12	3 13 3 8	4 3 1 4	4 12 3 0	8
9	8 2 2	17 3 26	1 7 1 22	1 16 3 18	2 6 1 14	2 15 3 10	3 5 1 6	3 14 3 2	4 4 0 26	4 13 2 22	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·84	17·68	26·52	1 7·36	1 16·2	1 25	2 5·8	2 14·7	2 23·5	3 4·4	3 13·2	3 22	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × $7\frac{1}{2}$ in. × 105 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	4 14 2 16	9 9 1 4	14 3 3 20	18 18 2 8	23 13 0 24	28 7 3 12	33 2 2 0	37 17 0 16	42 11 3 4	0
10	0 9 1 24	5 4 0 12	9 18 3 0	14 13 1 16	19 8 0 4	24 2 2 20	28 17 1 8	33 11 3 24	38 6 2 12	43 1 1 0	10
20	0 18 3 20	5 13 2 8	10 8 0 24	15 2 3 12	19 17 2 0	24 12 0 16	29 6 3 4	34 1 1 20	38 16 0 8	43 10 2 24	20
30	1 8 1 16	6 3 0 4	10 17 2 20	15 12 1 8	20 6 3 24	25 1 2 12	29 16 1 0	34 10 3 16	39 5 2 4	44 0 0 20	30
40	1 17 3 12	6 12 2 0	11 7 0 16	16 1 3 4	20 16 1 20	25 11 0 8	30 5 2 24	35 0 1 12	39 15 0 0	44 9 2 16	40
50	2 7 1 8	7 1 3 24	11 16 2 12	16 11 1 0	21 5 3 16	26 0 2 4	30 15 0 20	35 9 3 8	40 4 1 24	44 19 0 12	50
60	2 16 3 4	7 11 1 20	12 6 0 8	17 0 2 24	21 15 1 12	26 10 0 0	31 4 2 16	35 19 1 4	40 13 3 20	45 8 2 8	60
70	3 6 1 0	8 0 3 16	12 15 2 4	17 10 0 20	22 4 3 8	26 19 1 24	31 14 0 12	36 8 3 0	41 3 1 16	45 18 0 4	70
80	3 15 2 24	8 10 1 12	13 5 0 0	17 19 2 16	22 14 1 4	27 8 3 20	32 3 2 8	36 18 0 24	41 12 3 12	46 7 2 0	80
90	4 5 0 20	8 19 3 8	13 14 1 24	18 9 0 12	23 3 3 0	27 18 1 16	32 13 0 4	37 7 2 20	42 1 1 8	46 16 3 24	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs	t. c. q. lbs.	Weight.
	47 6 1 20	94 12 3 12	141 19 1 9	189 5 2 24	236 12 0 16	283 18 2 8	331 5 0 0	378 11 1 20	425 17 3 12	473 4 1 4	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

Tables of all Commercial Sizes of Different Rolled Steel Sections will appear in future issues.

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 107 lbs. per foot.

Ft.	0	10	20	30	40	50	60	70	80	90	Ft.
Ft.	c. q. lbs.	c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft.
0	..	9 2 6	0 19 0 12	1 8 2 18	1 18 0 24	2 7 3 2	2 17 1 8	3 6 3 14	3 16 1 20	4 5 3 26	0
1	0 3 23	10 2 1	1 0 0 7	1 9 2 13	1 19 0 19	2 8 2 25	2 18 1 3	3 7 3 9	3 17 1 15	4 6 3 21	1
2	1 3 18	11 1 24	1 1 0 2	1 10 2 8	2 0 0 14	2 9 2 20	2 19 0 26	3 8 3 4	3 18 1 10	4 7 3 16	2
3	2 3 13	12 1 19	1 1 3 25	1 11 2 3	2 1 0 9	2 10 2 15	3 0 0 21	3 9 3 27	3 19 1 5	4 8 3 11	3
4	3 3 8	13 1 14	1 2 3 20	1 12 1 26	2 2 0 4	2 11 2 10	3 1 0 16	3 10 3 22	4 0 1 0	4 9 3 6	4
5	4 3 3	14 1 9	1 3 3 15	1 13 1 21	2 2 3 27	2 12 2 5	3 2 0 11	3 11 3 17	4 1 0 23	4 10 3 1	5
6	5 2 26	15 1 4	1 4 3 10	1 14 1 16	2 3 3 22	2 13 2 0	3 3 0 6	3 12 3 12	4 2 0 18	4 11 2 24	6
7	6 2 21	16 0 27	1 5 3 5	1 15 1 11	2 4 3 17	2 14 1 23	3 4 0 1	3 13 3 7	4 3 0 13	4 12 2 19	7
8	7 2 16	17 0 22	1 6 3 0	1 16 1 16	2 5 3 12	2 15 1 18	3 4 3 24	3 14 3 2	4 4 0 8	4 13 2 14	8
9	8 2 11	18 0 17	1 7 2 23	1 17 1 1	2 6 3 7	2 16 1 13	3 5 3 19	3 15 2 25	4 5 0 3	4 14 2 9	9

Weight of Beam, advancing by inches.

Ins.	1	2	3	4	5	6	7	8	9	10	11	12	Ins.
Weight.	lbs.	lbs.	lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	q. lbs.	Weight.
	8·92	17·84	26·76	1 7·68	1 16·6	1 25·5	2 6·4	2 15·3	2 24	3 5·2	3 14·1	3 23	

Weights of Lengths of Rolled Steel Sections.

Beam 24 in. × 7½ in. × 107 lbs. per foot.

Ft.	0	100	200	300	400	500	600	700	800	900	Ft.
Ft.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Ft
0	..	4 15 2 4	9 11 0 8	14 6 2 12	19 2 0 16	23 17 2 20	28 13 0 24	33 8 3 0	38 4 1 4	42 19 3 8	0
10	0 9 2 6	5 5 0 10	10 0 2 14	14 16 0 18	19 11 2 22	24 7 0 26	29 2 3 2	33 18 1 6	38 13 3 10	43 9 1 14	10
20	0 19 0 12	5 14 2 16	10 10 0 20	15 5 2 24	20 1 1 0	24 16 3 4	29 12 1 8	34 7 3 12	39 3 1 16	43 18 3 20	20
30	1 8 2 18	6 4 0 22	10 19 2 26	15 15 1 2	20 10 3 6	25 6 1 10	30 1 3 14	34 17 1 18	39 12 3 22	44 8 1 26	30
40	1 18 0 24	6 13 3 0	11 9 1 4	16 4 3 8	21 0 1 12	25 15 3 16	30 11 1 20	35 6 3 24	40 2 2 0	44 18 0 4	40
50	2 7 3 2	7 3 1 6	11 18 3 10	16 14 1 14	21 9 3 18	26 5 1 22	31 0 3 26	35 16 2 2	40 12 0 6	45 7 2 10	50
60	2 17 1 8	7 12 3 12	12 8 1 16	17 3 3 20	21 19 1 24	26 15 0 0	31 10 2 4	36 6 0 8	41 1 2 12	45 17 0 16	60
70	3 6 3 14	8 2 1 18	12 17 3 22	17 13 1 26	22 9 0 2	27 4 2 6	32 0 0 10	36 15 2 14	41 11 0 18	46 6 2 22	70
80	3 16 1 20	8 11 3 26	13 7 2 0	18 3 0 4	22 18 2 8	27 14 0 12	32 9 2 16	37 5 0 20	42 0 2 24	46 16 1 0	80
90	4 5 3 26	9 1 2 2	13 17 0 6	18 12 2 10	23 8 0 14	28 3 2 18	32 19 0 22	37 14 2 26	42 10 1 2	47 5 3 6	90

Ft.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	Ft.
Weight.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	t. c. q. lbs.	Weight.
	47 15 1 12	95 10 2 24	143 6 0 8	191 1 1 20	238 16 3 4	286 12 0 16	334 7 2 0	382 2 3 12	429 18 0 24	477 13 2 8	

COMPILED AND ARRANGED BY T. E. WOODHOUSE.

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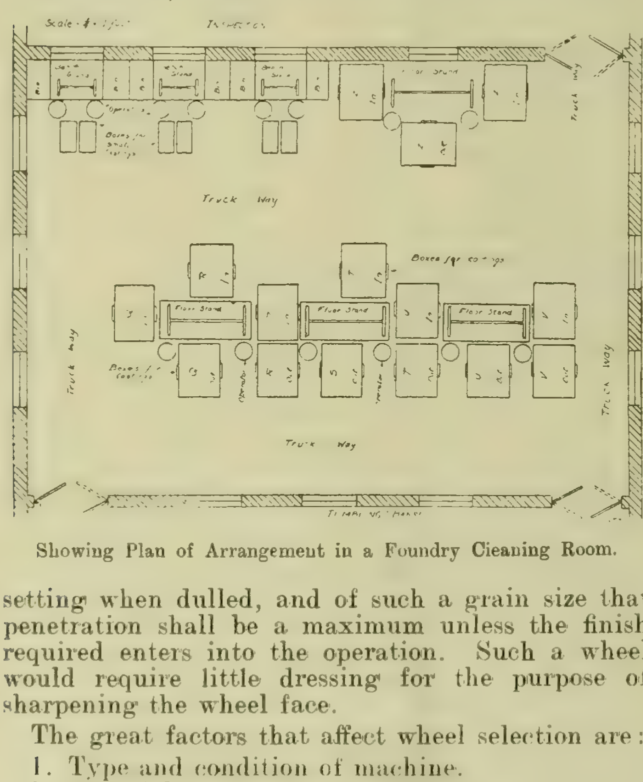
both cases the castings ground were identically the same.

Vibration can be greatly reduced by the use of heavy machines bolted securely to a concrete floor. This is necessary to absorb the slightly out of balance condition that any grinding wheel may inherently have or acquire when worn slightly out of round.

The Wheel.

Cast iron is a metal of comparatively low tensile strength. Because of this, carbide of silicon should be employed as the abrasive. This is called Crystolon by the Norton Company, and is a tremendously hard substance, and just brittle enough to shatter when necessary. This, in connection with the correct grain size and bond strength of wheel, produces an efficient tool. The great question generally is what grain and grade (bond strength) must the wheel be for snagging cast-iron castings. Off-hand, grain 20 grade S might be recommended, but different conditions so influence the selection that a test is often advisable. The wheel should be of such a bond strength that grains shall tear out of their



Showing Plan of Arrangement in a Foundry Cleaning Room.

setting when dulled, and of such a grain size that penetration shall be a maximum unless the finish required enters into the operation. Such a wheel would require little dressing for the purpose of sharpening the wheel face.

The great factors that affect wheel selection are:

1. Type and condition of machine.
2. Material, size and shape of castings.
3. Speed of wheel.
4. Personal factor due to operator.

We cited above a case of *poor* versus *good* machine equipment and the effect on wheel wear. To remedy the abnormally excessive wheel consumption much harder wheels were installed. This had the desired effect of prolonging the life as well as better preserving the shape of the face, but at a sacrifice of the cutting. However, it was more efficient to use the harder wheel in spite of the slight decrease in cutting in that particular case.

Large castings generally require a coarser, harder wheel than small castings. This is because the pressure exerted by the operator is usually greater. Also the inertia or that property which governs the rebound of the casting from the wheel is greater. In general, the greater the mass of the casting is, in comparison to the mass of wheel, the harder must be the wheel, other things being equal. Coarse grinding wheels remove metal most rapidly when the castings are soft. This is readily understood when grain penetration is remembered. On the other hand, for harder castings or castings having a hard skin, slightly finer grained wheels are best. In addition to these considerations of the castings is the shape. Thus, stove plates, for example, where the grinding is always the removal of sharp fins and flashes, and where the wheel edge is constantly used for cleaning corners, a finer, harder wheel must obviously be used, because of the dressing action, and the small contact of work on wheel.

By personal factor is meant the aggressiveness of the workman. When on piecework it is very noticeable that the men "punish" the wheel more than when on day rate. Under such conditions of increased pressure and roughness, a harder wheel must be employed.

For efficient running according to the design of the wheel it should never run much less than 5,000 s. f. p. m. nor more than 6,000 for safety's sake. The importance of maintaining this speed between these two limits cannot be expressed too strongly. As the wheel speed decreases, the rate of cutting decreases proportionally, provided the pressure is maintained equally and the wheel wear in cubic inches per unit of product increases. The first is quite obvious, if each grain is considered in the light of a tooth on a cutter. The second is true because the wheel acts softer as the wheel decreases in peripheral speed.

There is, therefore, a double loss—production and wheel structure. In practice, when a piece-rate is in use, an operator must exert more pressure upon the wheel so that a greater chip may be cut by each grain to compensate for the loss in speed. This causes excessive wheel wear. The total life of a snagging wheel is from 20 per cent to 30 per cent less than one might suppose when calculating from the life of the first $\frac{1}{2}$ in. of diameter consumed. This is in reference to wheels 16 in. and over in diameter.

Because of the vital importance in maintaining the proper wheel speeds, many foundries have adopted proper methods to effect this when their stands are not self-contained and equipped with variable-speed motors and when they are not belted to jack shafts with cone pulleys. This is by using the same wheel successively on two or three different machines, each having successively a higher speed. For example, a 20 in. wheel is worn down to 16 in. diameter on one machine having a revolution per minute of about 1,125. It is then taken off and mounted on a second machine the revolutions per minute of which is about 1,450, and lastly at 12 in. it is put on a bench stand, the spindle of which revolves at about 1,900 revolutions per minute.

In the modern core room one usually finds a wheel in operation for cutting off cores. This operation can be done very nicely on a grain 24 "Crystolon" rubber wheel $\frac{1}{8}$ in. in thickness, and usually from 12 in. to 14 in. in diameter.

There should also be a wheel operating in a convenient place for the chippers to sharpen their chisels

and upon which the moulders can keep their shovels straight and sharp. Such a wheel must be finer and softer than the snagging wheel in the cleaning room so as not to draw the temper from the tools. For this a wheel made of Alundum in grain 36 grade O or P can safely be recommended.

The selection of the proper wheel, therefore, in the cleaning room is a great step toward reducing both overhead and labour costs.

Payment of Labour.

In many cleaning rooms the operators are still paid by the hour. This practice is buying time rather than work done. Whenever a piece-rate system can be installed, the step should be taken without further question.

increase, or a 33 per cent decrease per 1,000 lb. of castings ground. The success of this system is in the setting of the rates based on scientific principles.

Large industrial foundries have no trouble in this respect, because here there is a constant duplication of parts for which an accurate rate can be set either per 100 pieces or per ton. A jobbing foundry finds it more difficult, but even here it might be accomplished. By dividing the castings, which can be ground on floor or bench stands, into three groups, A, B and C, the rate per ton for each can be quite satisfactorily determined. Such a classification would be approximately such that group A castings contained those weighing approximately $1\frac{1}{2}$ lb. and less, group B from $1\frac{1}{2}$ lb. to 7 lb., and group C from

INDIVIDUAL RECORD SHEET.

Workman No. 116.

	H	I	J	K	L	M	N	O	P	Q	R	S	T
Wheel Make and Specification.	Machine Number.	Class of Castings.	Date and Diameter on	Date and Diameter off	Total working hours in use.	Volume of Wheel used (cu. in.).	Total Tons of Castings ground.	Total Earnings of Operator.	Cost of Wheel Material consumed.	Wheel cost per ton of Castings.	Overhead cost per ton of Castings.	Labour cost per ton of Castings ground.	Total grinding cost per ton.
Norton 20 × 2—24R	18	C	July 18 20″	Sept. 3 16″	375	226	300	$261	$9·04	$0·030	$1·250	$0·90	$2·180
Norton 20 × 2—20S	18	C	Sept. 3 20″	Oct. 28 16″	450	226	335	301	9·04	0·027	1·345	0·90	2·272

I = Class of castings which are from 7 lb. to 60 lb.

M = Cubic inches of wheel structure consumed $= 2\pi(R^2 - r^2) = 2 \times 3{\cdot}1416\,(100 - 64)$. R = radius of 20″ wheel, r of 16″.

P = If wheel is finally discarded at 9″ diameter, the available abrasive material costs 4 cents per cubic inch. This can be figured by looking up list price of Crystolon wheel minus 50 % discount and dividing by the number of cubic inches the wheel has outside of the 9″ centre which is discarded.

Q = P ÷ N.

R = L multiplied by the overhead per hour (which in this case equals $1·00) divided by N $= \frac{L\,(1{\cdot}00)}{N}$.

S = Labour cost per ton—piece rate or figured from hourly rate. This case is piece rate.

T = Q + R + S.

The increased production is almost always remarkable. Even if production increase were alone the result and the piece-rate were such as would be figured from old performances at day rate, there would be a large decrease in overhead. Thus, at 1 dol. an hour per man overhead, an increase in production of 50 per cent means a reduction of 33 per cent in the overhead charge per unit of product, or approximately 3 dols. per day per man for a nine-hour day. For example, if 1,000 lb. of a certain size casting could be snagged in one hour, and an increase in production of 50 per cent were effected, the operator would then grind 1,500 lbs. in the same time. The overhead charge at 1 dol. per hour would be 1 dol. per 1,000 lb. before the 50 per cent production increase and ·66 dols. per 1,000 lb. after the

7 lb. to 60 lb. All group A castings would be ground on bench stands, while B and C would be ground on the floor stands. For class A, from 200 lb. to 500 lb. could perhaps be snagged per hour or an average of perhaps 350 lb. per hour per man. Perhaps 800 lb. per hour could be done for the intermediate and 1,500 lb. per hour per man for the class C castings. If it was found that these figures held such an average over a period of a month, the basic rate could then be determined.

Under such conditions the operators become keen observers of wheel action and favour the fast-cutting wheel which is economical even at the sacrifice of long life, because the saving due to increased production is much greater than that lost by increased wheel cost in the cast iron cleaning room.

Grinding Costs.

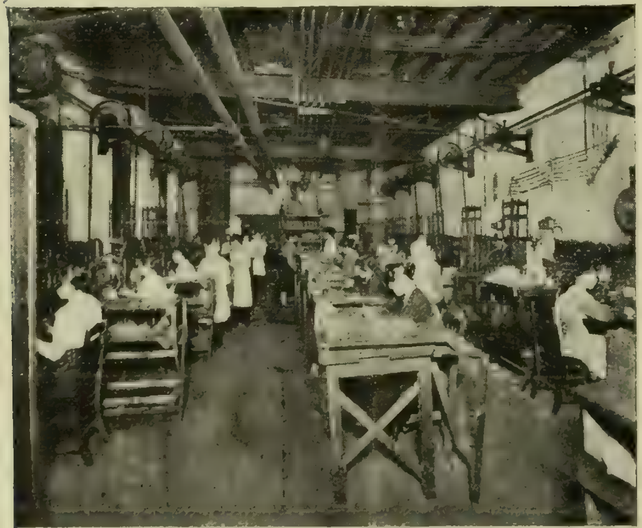
A record kept by the foreman as to the performance of wheels and operators enables one to detect instantly the good and poor workman, the average life and productiveness of wheels in comparison to new trial wheels that are being tested. The actual cost of grinding which is the sum of three factors—wheel cost, overhead cost, labour cost—enables the foreman to direct his energies toward their reduction. A record of this kind also enables one to determine the feasibility of instituting the piece-rate system and a fair idea of the rates which might be set. Herewith is shown a record sheet for each workman. The most efficient wheel to use will show itself very quickly in the final column—the total grinding cost.—*Grits and Grinds.*

EFFICIENCY IN ELECTRIC LAMPS.

GREAT DEVELOPMENT IN THE "POPE" WORKS AT WILLESDEN.

At one time there were many makers of electric lamps in Great Britain, but now, with their war experiences to bestir their energies, they have for the most part given up the notion of working against huge lamp manufacturing corporations both at home and abroad.

As against this policy, however, the Pope Electric Lamp Co., with Mr. F. R. Pope at its head, devotes itself entirely to the manufacture of electric lamps, and a visit to their extensive works at Willesden



Carbon Filament Lamp Department.

provides ample evidence of the manner in which a large and competent staff strive, with the aid of ingenious and high-class machinery, to ensure perfection in the production of the Pope lamps. From the first process to the last no pains are spared, no engineering or scientific test is omitted, to turn out a perfect lamp, and to this may be attributed the high place of Elasta lamps in modern illumination.

In addition, the firm make vacuum lamps, gas-filled lamps, and even carbon filament lamps are still turned out in thousands daily at the Pope works, the demands for the carbon filament lamps being still steady from overseas. In the spacious workrooms hundreds of clever and delicate-fingered girls literally "play with fire" in some of the processes necessary in turning out these four or five different types of lamp. By means of tiny gas jets, aided by blow-pipes, fragile glass globes are handled with a degree of skill which is surprising. The glass is melted and moulded to the operator's wish, all with

Lamp Making Department.

the knowledge that subsequently each lamp will be subjected to the severest of scientific tests before being packed for distribution to the public.

With such a highly-trained and intelligent staff of workers of both sexes, it is not surprising that the Pope electric lamps have made a name for themselves in the markets of the world. Since the business was established in 1904, acre after acre has been added to the vicinity of the initial works, and new buildings

Gas-filled Lamp Making Department.

have become necessary to house the workers and plant necessary to cope with the increasing demands for the Pope lamps. The headquarters of the sales organisation have now been established at Elasta House, Arthur Street, New Oxford Street, London, and in every way the firm has shown its readiness and capacity to meet the demands of its growing army of customers and the constant expansion of its business.

COAL IN SPAIN.

According to information published by the Mining Department, the reduction of output by coal miners in the basin of the Asturias from 139 tons in 1913 to 84 tons in 1919 is not in any way a result of the introduction of the eight-hour day, for this measure only came into force at the end of 1919, and could not have influenced to any appreciable extent the production of coal. The same falling off has been noted in other districts, where the production per miner has diminished in a greater proportion than would correspond to the reduction of working hours.

The coal mines of the province of Badajoz acquired a certain importance during the war, but the bad quality of the coal extracted from them led to a cessation of their exploitation as soon as the demand for coal diminished and the question is now being considered of erecting works for the production of briquettes in order to utilise the mines.

In the great coal basin of Puertollano very important installations are being made with the object of improving the quality of the coal and the means of transport. Among other works may be mentioned the construction of a branch line of normal gauge which already serves two concessions, and is to be prolonged in order to reach others.

The Penarroya Mining and Metal Company, which has great interests in this basin, has completed a washing plant with a capacity of a hundred tons per hour, and is enlarging its distillation works.

The latter industry seems destined to great activity, for the Puertollano basin is rich in light shales yielding up to 200 litres of oil per ton; this oil furnishes essences almost identical with those obtained from petrol.

In the province of Santander, active search is being made for deposits of bituminous shale. One concession of bituminous sands covers 234 hectares.

Lignite distillation is being studied in the province Lerida, where rather important deposits of the combustible are found. Experiments made in a small way have given fairly satisfactory results and the question is now being considered of repeating them on a large scale.

Investigations made in the coal fields of the province of Corroba have proved that their extent is much greater than was supposed. Seams have been met with at a depth of 512 metres.

In the province of Corunna nothing has been done to exploit the Puentes de Garcia Rodriguez lignite deposits which cover an area of over 4,000 hectares. The general impression is that the most profitable method of utilising them would be to distil the lignite in order to make use of the bye-products rather than to manufacture briquettes.

The Mines Department has discovered a lignite field in the province of Granada which appears to be of importance.

In the province of Guadalajara the same department is investigating the Valdesoto coal basin.

Preparations are being made to exploit the great deposits of lignite in the province of Murcia, discovered a few years ago in the districts of Mula, Alhama, Totana and Pliego. Some of the strata are over a metre in thickness. If the investigations yield the results hoped for, the lignite will be used for the production of high tension electricity for the use of the whole Murcia mining district, which is rather short of power, the hydro electric company now supplying it not being able to meet all the demands of an intensive exploitation. For the time being this is the only use to which the lignite can be put owing to the lack of means of communication, which necessitates a journey of six or seven kilometres on mule-back, and then some 15 kilometres in wagons in order to reach the nearest railway station. The end of the war and the consequent fall in price for this kind of combustible led to a sudden stoppage of all works connected with its exploitation.

In order to utilise the small coal which predominates in the output of the coal mines of the province of León, several mining companies and industrialists of the region have erected briquette factories which, when they are working to capacity, will be able to turn out about 600 tons of briquettes in an eight-hour day.

The same policy is being adopted in the province of Palencia, where small coals constitute 60 per cent of the total production. Three briquette works are in course of installation and two have already begun working.

Briquette production in Spain during 1919 reached a total of 590,000 tons, the highest figure yet reached.

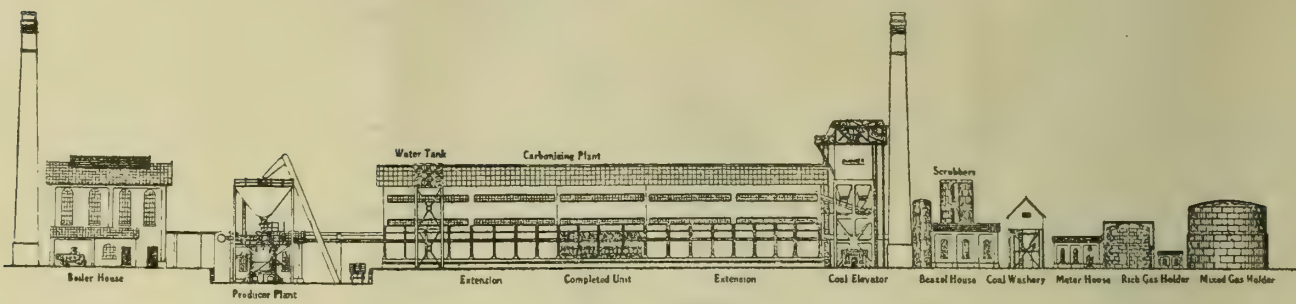
The Altos Hornos de Vizcaya and the Sociedad Basconia, both of Eilbao, have installed aero-pulverisors for use with pulverised coal. It is anticipated that considerable economy will be effected by by this means.—Reuter.

THE STRIKE IN SHIPYARDS.

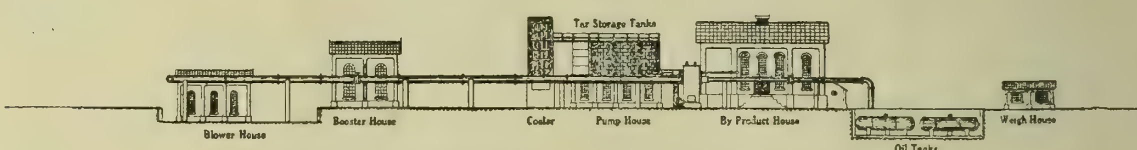
THE strike of carpenters and joiners is having a serious effect on the shipbuilding and ship-repairing industry. It is stated that some twenty thousand men are affected, but if the strike lasts any time the number will be largely augmented by the kindred trades. It is especially regrettable just now when the industry is in a very bad condition and when our chief repairing centre, the Mersey, has not yet recovered from the recent shipwrights' strike.

The position may be summarised thus: Last April the Shipbuilding Employers' Federation granted a general increase of 12s. per week, partly, it is stated by the men's officials, because of the rise in the cost of living. Probably the employers were influenced by the possibility of a proportion of the men going on building work, but the position has changed considerably since April, when shipbuilding was in a healthy condition. One immediate result of the concession was to create a great deal of dissatisfaction among the other trades and this no doubt accounts for the employers' reason, as expressed in their ultimatum, that it is "in the interests of the industry and of all employed in it" that the reduction be made. It appears to us that the employers made a grave error in granting the increase to a section of the industry, in the first place, when they could not afford to give it to all the trades.

CARBONISATION OF COAL AT BARNSLEY.



FRONT ELEVATION



ELEVATION SHEWING BUILDINGS AT THE BACK OF CARBONISING PLANT.

The works erected at Barnsley for the low temperature carbonisation of coal which have been shut down for some time are now being reopened. The reconstruction and expansion of the works was delayed owing to the moulders' strike. The process of low temperature carbonisation has been frequently described in our columns. Briefly, it consists in utilising every constituent in coal which by the usual process of carbonisation is lost. After extracting from the coal motor spirit, and heavy fuel oils and other valuable by-products, the residue is a smokeless fuel which will be in great demand. Several large electric power corporations have decided to introduce the system in connection with their generating plant. The chairman of the Low Temperature Carbonisation Company is Colonel Sir Henry Goold-Adams, who played an important part during the war in connection with the Inventions Department of the Ministry of Munitions, and was chairman of the Committee on Nitrogen Products. The experts connected with the undertaking are confident that this system will not only help to relieve the fuel situation in the country, but also provide us with a national supply of oil. The Barnsley plant will have a capacity in the near future of dealing with 70,000 tons of coal per annum, and ultimately of 175,000 tons per annum. The plant will produce the following products : Smokeless fuel, fuel diesel and lubricating oils, creosote and disinfectants, motor spirit, sulphate of ammonia, and gas for power and lighting.

AMERICAN ENGINEERING NOTES.

An interesting annual comparison of conditions in the coal-mining industry has been made by our Government Bureau of Mines during the past 18 years. That for 1918 has just been made available..

The largest production per man during any of the 18 years was 1,134 short tons (2,000 lb.), which represented the average production for each underground employee in the coal mines of the United States during 1918.

New South Wales came next with an average per underground worker of 814 tons. British Columbia ranked third with 790 tons and Nova Scotia fourth with 718 tons. The smallest individual output for recent years was that of Japan for 1917, viz., 155 tons, although in 1901 India showed an average of only 122 tons, this being the lowest for any year for the countries under consideration.

* * *

The individual output for Great Britain was until 1910 above that of Prussia, but in 1911 Prussia passed the British record, and has maintained the lead since that time. In Great Britain the output of coal for each underground man averaged 400 tons for 1901, increasing to 419 tons, then steadily declining until in 1918 the output per man was only 337 tons. The daily output per man has also declined in Great Britain from 1·55 tons in 1905 to 1·19 tons in 1918.

* * *

Our production is about 600,000 000 short tons a year, while yours is some 300,000,000 short tons. At the beginning of this 18 year period one-fourth of the bituminous coal in the United States was mined by machine, while at the end of the period the quantity of machine-mined coal was about 56 per cent of the total bituminous production. It must, however, be borne in mind that the high average thickness of the coal seams and the comparatively uniform and regular position of the coal beds greatly facilitate the work of the miner. About 80 per cent of the bituminous coal is mined from seams between 3 ft. and 10 ft. thick, while seams less than 2 ft. thick do not produce as much as 1 per cent of the total production Nor is the coal mined at as great depths in this country as is the case in some of the foreign fields.

I have a report of the Department of Mines of West Virginia from which I find that the Commonwealth has 6,080,000 acres of coal lands, each of which, it is said, may reasonably be expected to yield some 100,000 tons, or a total of some 60 billions of tons of coal. In 1918 the State mined 85,000,000 tons.

* * *

For the first time an electrically-driven cargo ship left New York recently under private ownership. She was the s.s Eclipse. mentioned in this correspondence a short time ago. She was originally turbine driven.

* * *

While you have your "gloomy dean," we have our gloomy shipbuilder, Ferguson by name, who comes out with the prediction "that more than half of the American shipbuilding yards will be forced to close down for want of work; that the Shipping Board has more vessels of the freighter type than it can operate successfully, and there can be no American merchant marine without some form of protection." He is the president of the Newport News Dry Dock & Shipbuilding Co.

If one may judge from the disclosures now being made of mismanagement and incompetency in the Shipping Board, and if the charges of colossal graft in shipbuilding and operation are true, our shipbuilder has indeed cause for pessimism.

* * *

Thirty thousand motor cars and trucks are serving the various Departments of the Governments of the 48 States of this country. Twenty-three thousand are trucks and automobiles used by the States for the improvement of the highways.

* * *

When the problem of separating oil from the oil sands lying to the north of Edmonton, Alberta, has been solved, oil in sufficient quantities to supply the world for 600 years will be released, according to the estimates of the principal of Alberta University, who has made a special study of them. Solution of the problem of successful separation is expected soon.

* * *

Announced from Mexican Embassy at Washington, November 11th, that according to official estimates Mexico's 1920 production

of petroleum will amount to 140,000,000 barrels, or one-fifth of world's total. This compares with production of 88,000,000 barrels in 1919, and is more than twice as much as was taken from fields in 1918 and 1917.

* * *

Professor Ernest H. Peabody told a meeting of naval architects that "if there is another great war it will be won by the nation most plentifully supplied with fuel oil." Of course, naval men the world over know this, and, of course, their Governments are going to get hold of as much oil territory as possible. They would be fools if they didn't, League of Nations or no League.

* * *

W. B. Dickson, vice-president of the Midvale Steel Co., always struck me as a sound and conservative industrial leader. I like to listen to him talking about the practical problems of everyday life. He is one of the "clean desk" men. Consequently, when he says that "industrial feudalism will result from the continuation of the United States Steel Corporation and similar dominant companies in other industries and of the autocratic policies they are now pursuing," serious people think even a little harder than they have been doing during the last two years or so.

* * *

Workers in the steel industry are making comprehensive plans to fight the "open shop," and are planning a labour war with the Steel Trust, which has hitherto successfully resisted the application of the "closed shop" principle in the works it controls.

* * *

Ground was broken recently at the Gowanus Terminal of the New York State Barge Canal for the erection of the first State-owned and controlled grain elevators, the capacity of which is to be 1,250,000 bushels. This enterprise is intended to be the entering wedge for the recovery of the port's lost export trade in grain.

* * *

The Association of Railway Executives have made known one of the urgent transportion needs of the country to the effect that 105,000,000 dols. must be spent at once for the construction of 1,800 locomotives.

* * *

There has already been briefly described in these notes a new automatic straight-air brake and its introduction on one American railway. Since then five other railway companies have placed orders for this new safety device.

* * *

"The field in the die-casting line has been largely extended," said the head of one of our larger concerns engaged in this work, "owing to the development of high tensile strength alloys, and are now turning out parts for electric motors, washing machines, sewing machines and other mechanical devices not heretofore successfully made by the die-casting process."

* * *

Railroad Information Bureau, New York, announced on November 11th that the average cost of running a freight train one mile, as indicated by comparison of principal items of expense selected by Inter-State Commerce Commission for statistical purposes, was 23·2 per cent greater in July, 1920, than in July, 1919. Total of selected accounts was 1·89 dols. per mile this year and 1·54 dols. last year.

* * *

Announced from Philadelphia that Pennsylvania Railroad system will cut down number of its operating employees to absolute minimum in anticipation of traffic slump this winter. First step in general reduction came on November 12, when railroad dropped from pay rolls 1,350 men employed at Altoona shops, approximately 15 per cent of total number employed there.

* * *

One may gather what the automobile industry contributes to the American railway from the fact that it pays approximately 100,000,000 dols. in freight charges, 500,000 freight cars are required per year to carry automobiles, trucks and finished parts, exclusive of tyres and unfinished materials: 570,730 machines have been delivered in the last 21 months, representing a potential business of an additional 170,000 car loads. Of course, petrol, lubricating oil and accessories required by car users swell the volume of railroad freight business.

* * *

In the past year or so we have had two plans for railroad operation prominently before the public. One, the so-called Esch Cummins, was designed to run the railways for the production of transportation, and was adopted. The other, known as "the Plum plan," frankly intended by the American Federation of Labour, the organisation which caused it to be introduced, to run the railways for the production of wages, failed to receive any very serious consideration. The Federation during the Presidential campaign put out a well-organised propaganda to reward its friends and defeat its enemies.

* * *

In truth, unionism has failed politically wherever it has made its greatest fights. Of late the situation has changed. As the National Founders' Association puts it: "The open-shop movement is sweeping the country. The proponents of closed-shop unionism, Government ownership and class-regulated Governmental administration have been buried beneath an avalanche of votes."

* * *

But, as ever, danger attends political landslides and big majorities. They beget, particularly in democracies, official arrogance, unless the leaders keep cool, weigh carefully every proposed measure, putting more business in politics and less politics in business.

Trade Items, Notes, &c.

The Secretary of the Department of Scientific and Industrial Research makes the following announcement: Sir John Francis Cleverton Snell, member of the Council of the Institution of Civil Engineers and past president of the Institution of Electrical Engineers, has been appointed by an Order of Council, dated the 23rd day of November, 1920, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

Women Engineers.—Representatives of the Engineering and National Employers' Federation met those of the National Federation of General Workers and allied unions, including the National Federation of Women Workers at York recently, in reference to the question of an advance in wages to women employed in the engineering and allied trades. The claim amounted to an increase of 30s. a week on the present rates. Finally the matter was left in the hands of the central authority of employers and the unions.

Barimar Branches in Provinces.—Barimar Ltd. have now opened service depots in Birmingham, Manchester, Newcastle and Cardiff, at each of which their special metallurgical process will be in operation. The existence of these depots will save customers at a distance the expense and delay—and the latter is often considerable in these abnormal times—of sending broken parts or scored cylinders up to the headquarters of Barimar in London. In cases where it is impossible to send heavy units to London, or to one of the Barimar branches, expert welders are despatched with portable plant to make the repairs on the spot.

Engineers and the Shift System.—At the resumed conference at York of the Employers' Federation and representatives of the Amalgamated Engineering Union, a satisfactory arrangement was made for introducing the shift system to absorb unemployment. The provisions recommended for acceptance are applicable nationally, and the system will be the subject of consultation with the works committees. Each shift is to have half-an-hour's break for each meal. The first shift will consist of 43 hours, for which 47 hours will be paid: the second $37\frac{1}{2}$ hours, for which 47 will be paid; the third $37\frac{1}{2}$ hours, for which 50 will be paid. The following division of the day is recommended, subject to modification according to local consideration:—Monday to Friday: First shift, 6 to 2; second shift, 2 to 10. Saturday: 6 to noon. The provisions are to apply to workmen employed in engineering, boiler-making, and foundry departments. Consideration is also to be given to maintenance other than in those departments.

Motor Pumps for Roumania.—The Commercial Secretary of His Majesty's Legation at Bucharest has forwarded to the Department of Overseas Trade a translation of a decree which appeared in the *Monitorul Official* of the 5th November authorising the opening of a credit of over five million lei, stated to be for the construction of a new petroleum pipe line between Baicoi and Giurgiu. Of this credit: (*a*) 1,715,000 lei shall be used for the works of masonry, transport, etc., on the pipe line

Baicoi-Giurgiu; (*b*) 2,058,000 lei ditto, for the pipe line Chitila-Giurgiu; (*c*) 40,000 lei for dismantling and rebuilding the four reservoirs in the port of Giurgiu; (*d*) 1,500,000 lei for the purchase of a group of motor pumps. It appears that this proposal is really for the formation of a new line by the utilisation of existing material, save in so far as concerns the pumps. British firms who are interested in the supply of motor pumps should approach the Roumanian Ministry of Communications through their own agent in Bucharest.

COASTAL MOTOR BOATS.—Everyone knows the very important service performed by the coastal motor boats in the naval part of the war, when they proved the most successful weapon against the German submarine and crowned their activities by raiding Kronstadt Harbour and sinking a number of Bolshevik battleships. They are now to be continued as a regular arm of the new navy, and the first to be completed of the Admiralty's post-war programme successfully passed her official trial recently, when a mean speed of 37 knots was obtained after a series of trials over the official Admiralty course, and the boat handed over by her builders, Messrs. John I. Thornycroft & Co. Ltd. During the war three types of coastal motor boats were built, commencing with the 40-ft. boat designed and built by Thornycrofts and armed with one torpedo. Two larger models were subsequently developed measuring 55 ft. and 70 ft. respectively, until the largest type carried torpedoes, depth charges, Lewis guns and crew, and yet gave speeds up to 40 knots. The new boat just delivered is a 55-ft. C.M.B., which was the type that proved most successful, and there is no doubt the new C.M.B. service will render valuable aid in maintaining British naval power supreme on the seas.

DEPARTMENT OF OVERSEAS TRADE.—The vast amount of commercial good that has accrued through the establishment of the Department of Overseas Trade must be patent to every commercial trader of this country, and particularly to those traders who are exporters. Our industries—in fact, our life as a community—depends upon the export trade, and therefore those years of slothful indifference on the part of the old Governments of this country cannot be but bitterly regretted. To-day, however, we have a new spirit, and there is a very determined effort afoot to bring about expansion of our export trade. "It is an accepted fact that one of the principal requirements of the exporter is a constant supply of reliable information regarding the conditions obtaining in those overseas markets in which he is interested." That is the opening sentence of a chapter on "How the Department of Overseas Trade assists the British Exporter." The handbook in which this matter is contained gives an account of the Department, and a copy may be had by any merchant or manufacturer who applies to the Department at 35, Old Queen Street, Westminster, London, S.W.1, quoting reference No. 2092/TG. Much interesting information will be found in the handbook.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The fourth meeting of session of the Institution of Automobile Engineers, held in London on December 8th, was again accompanied by an innovation in that two short papers were read and discussed on the same evening. The result must be considered a most happy one, as the discussions, though short and sharp, were extremely vigorous and pithy. The subjects under discussion were "Roads and Vehicle Maintenance," by Colonel R. E. Crompton, and "The Combustion of Napthalene Solutions in Internal-combustion Engines," by L. S. Palmer, widely varying indeed in subject, but both equally interesting to the automobile engineer. The members of the institution have granted very large powers to the Council in consenting now to an all-round increase in subscriptions of 10s. 6d. per head for each class of member, "or such other sum as the Council may from time to time determine." Attendance at extraordinary general meetings is troublesome to the majority of members and expensive to the Institution, and occupies time which might be more profitably used. The idea of placing this power in the hands of the Council without further reference to the members is to save all this, and the Council certainly have in mind the hope that it may rather be possible to decrease, than necessary to further increase, the new rate of subscription. At all events, the tendency in the conduct of the affairs of the Institution has been of late so democratic that there is no question but that the Council would, through the medium of the monthly circular, consult with the members before taking such a step as making any further increase. The Council quite realise their responsibilities to the members, and that they hold office only to interpret the wishes of the members. These lines are penned because at each of the extraordinary general meetings at which the increase has been discussed the point was raised by one of the members present, though not pressed to an expression of opinion. It seems fitting that the first lady graduate of the Institution to be elected should receive special mention. The lady in question is Miss E. J. Linford, who is at present engaged on research work at Loughborough Technical College. The following is a list of meetings to be held under the auspices of the Institution during January: Tuesday, 4th: Meeting of the Wolverhampton members at the Technical School, Wolverhampton, at 7-30 p.m., when Mr. H. Stevens will read a paper on "The Problems of a Designer and how they affect Production." The chair will be taken by Sir Henry Fowler (president of the Institution). Visitors will be welcome to attend. Tuesday, 11th: Meeting of the Coventry Graduates at the Foremen's Institute, 7, The Quadrant, Coventry, at 7-45 p.m., when Mr. J. Newey will read a paper on "Cooling Systems," Mr. A. E. Berriman being in the chair. Members of all grades or visitors will be welcome to attend. Wednesday, 12th: General meeting of the Institution, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 8 p.m., when Captain S. Bramley-Moore will read a paper entitled "Recent Developments in Transmission." Sir Henry Fowler will be in the chair. Special cards of invitation to admit visitors may be obtained on application to the secretary, Institution of Automobile Engineers, 28, Victoria Street, S.W.1. Wednesday, 12th: Visit of the Birmingham Graduates to the works of the Austin Motor Co. Ltd., Northfield. Graduates will meet outside the works at 2-30 p.m. Monday, 17th: Meeting of the Scottish centre at the Royal Technical College, Glasgow, at 7-30 p.m., when Captain S. Bramley-Moore will read his paper entitled "Recent Developments in Transmission." The chair will be taken by Mr. D. Keachie. Visitors will be welcome to attend the meeting. Wednesday, 19th: Meeting of the Birmingham Graduates, at the Chamber of Commerce, New Street, Birmingham, at 7-30 p.m., when Mr. T. R. Florance will read a paper entitled "Relative Advantages of Two-stroke and Four-stroke Engines." The chair will be taken by Mr. J. E. Cooper. Thursday, 20th: Meeting of the London Graduates at 28, Victoria Street, London, S.W.1, at 8 p.m., when Mr. W. H. Wardall will read a paper entitled "Cylinder and Piston Wear." The chair will be taken by Mr. F. L. Martineau. Visitors will be welcome to attend the meeting. Tuesday, 25th: Meeting of the Coventry Graduates, at the Foremen's Institute, 7, The Quadrant, Coventry, at 7-45 p.m., when Mr. J. T. Hacking will read a paper on "Accessibility." The chair will be taken by Major B. W. Shilson. Members of other grades, and also visitors, are invited to attend. Saturday, 29th: Visit of the London Graduates to the works of J. A. Prestwich & Co. Ltd., Northumberland Park, Tottenham. Graduates meet outside the works at 2-30 p.m.

THE RECOVERY OF BELGIAN INDUSTRIES.

THE Ministry of Industry, Labour and Food Supply published in June and December last year figures, rapidly compiled, giving some idea of the extent of the recovery of Belgian industries. An investigation, which has recently been carried out by the Administration of Mines and the Labour Inspection Department, now gives a comprehensive view of the situation in Belgium at the present time.

Industrial establishments employing more than 20 workers employed in June, 1920, 606,960 workers, as against a personnel of 650,889 in June, 1919—that is to say, the number employed in 1920 represents 92 per cent. of those employed in 1913. In December of last year the number only amounted to 72 per cent. The mining industry is now employing even more workers than it did in June, 1913.

With regard to production during the first six months of 1920, of the 3,666 establishments existing in 1913 which furnished figures showing their production in 1920, 1,407, or 38 per cent of these concerns, recorded a production exceeding 75 per cent of their pre-war production. Rather more than half of these establishments are now employing more than three quarters of their pre-war personnel.

The most important reasons for inactivity are:

1. Lack of material resulting from destruction or pillage by the enemy, when, it is estimated, accounts for 21·09 per cent of forced idleness.
2. Lack of capital and delay in payment of indemnities (9·77 per cent).
3. Lack of orders (8·20 per cent).
4. Lack of raw materials (7·05 per cent).
5. Lack of labour (6·45 per cent).—(Reuter.)

REVIEWS.

THE TESTING OF MOTIVE-POWER ENGINES. By R. Royds. Longmans, Green & Co., 39, Paternoster Row, London. 21s. nett.

This is the second edition of the work, the first edition having been published as long ago as 1911. There is no more important part of engineering than effective testing, and the student cannot devote too much time to the subject, and when we say "student" we do not mean merely the youth at the technical college, but the more experienced practical engineer whose life ought to be, to a very considerable degree, a life of study.

The present edition of the book has been brought up to date by modifications and additions, although the scope of the first edition has been adhered to. The book is divided into sixteen chapters. The first chapter deals with principles covering motive-power engines, and, beginning with some principles of simple mechanics, goes on to deal with such matters as the "Otto" cycle for internal-combustion engines. There are many important definitions in this chapter, with which the average student who lifts the book will probably be familiar. The first three chapters are really a preparation for the descriptions and explanations of actual testing which are given in the succeeding chapters, and are quite necessary. It is not wise for an author of a work of this kind to presuppose considerable knowledge on the part of his readers, and interspersed with familiar and common facts are many principles which are less common. Having dealt at length with such matters as the measurement of pressure, temperature, and horse power, the author proceeds to their practical application.

The book is certainly comprehensive, and explains in detail the testing of locomotives, internal-combustion engines, and steam turbines. There are chapters on boiler tests, on refrigerator tests, and on air-compressors, and a very interesting chapter is the final one, which treats of water-turbines and pumps. Students will probabbly be attracted to special chapters in this book treating of subjects in which they desire to specialise. If it were a book which, after the preparatory chapters, travelled from the simple to the complex, one might cavil at the arrangement, but as each chapter is self-contained this does not matter so much. It is a book worthy of a place in every engineer's library, because, even after it has been well studied, it should be of great value for reference purposes.

COAL SAVING IN THE CHEMICAL INDUSTRY. By D. Brownlie, B.Sc. (Hon.), F.C.S. A.I.M.E.; 2s. 6d.

This is a reprint in brochure form of an article which appeared recently in a technical journal. It is really a record of fuel tests made on 60 steam-boiler plants of the chemical industry, and is a useful contribution to an important question. The tests were very exhaustive, and apparently every means was adopted to ascertain what the various boiler plants would do with the various kinds of fuel. The author endeavours to show that "the average net working efficiency of the boiler plants of the chemical industry is only about 58 per cent, and that by carrying out the reorganisation of these plants on modern scientific lines, it is possible to run them on an efficiency of, say, 75 per cent, with a consequent saving of about 23 per cent on the coal bill." Those figures are true of boiler plants other than those in the chemical industry, and it is this value that gives the booklet interest to all owners or managers of boiler plants.

A COURSE IN MACHINE DRAWING AND SKETCHING. By J. H. Dale, A.M.I.M.E. London: W. & R. Chambers Ltd., 38, Soho Square, W.1.

Another addition to the many books on this subject. It is an eminently practical book, and is intended for fourth and fifth year technical courses. There are innumerable drawings, and very little text, and the method of treatment is the result of the author's long experience as a teacher. He believes it is much better for the instructor to give local colour to the descriptive matter in his lectures. A very commendable feature is the method of pictorial presentation that has been chosen in preference to well-finished drawings, and this should make the book valuable not only to the students but to draughtsmen, because many draughtsmen who can turn out a highly-finished drawing fail in making picture views, and are not good at geometric projection.

In the preface the author says: "When teaching machine drawing the teacher should remember generally only one-third of the students are apprenticed draughtsmen. The average artisan requires machine drawing for practice in accuracy of measurement and rapid deciphering of complex drawings; hence high degree of neatness and finish should be expected only from the draughtsman." Is this sound advice? We doubt it very much. It may be true that the average artisan does not draw much, but the student, even if he is in the shop, may ultimately go to the drawing office, and the policy of making a distinct difference between the lad from the drawing office and the lad from the shops must be subversive of disciplnie in the class. The difference of opportunity for practice will be reflected in the work accomplished, but the teacher should certainly insist on neatness and accuracy from all the students in a class.

Foreign Notes.

Bombay Water Scheme.—The corporation has adopted the Tansa water scheme, providing for the supply of an additional 90 million gallons daily. The pipe lines for part of the distance will be steel; the type to be employed on the remaining distance is not yet settled.—Reuter.

New Company at Stockholm.—*Svensk Handelstidningen* reports that a new company has been formed at Stockholm with a capital of Kr.1,200,000 for the purpose of taking over Aktiebolaget Ygdrasil with its patents and methods for the manufacture of measuring instruments. The list of founders includes, in addition to Aktiebolaget Ygdrasil, Captain A. Setterwall and Mr. A. Hernmark.—Reuter.

Mack System of Storing Benzine.—*Svensk Dagbladet*, in an article on the Swedish system for storing benzine, known as the Mack system, says that this method, which is used almost exclusively in Sweden, has proved most efficient. The cisterns are provided with appliances which register automatically and accurately the quantity of oil in the cisterns, and the quantity drawn. The apparatus is manufactured at the Mack works at Midsommarkransen, not far from Stockholm. Reuter.

Swedish Industry and Foreign Competition.—*Svenska Dagbladet* publishes a statement by the head of Svenska Metallverken (Swedish Metal Works) regarding foreign competition, especially that of Germany where working costs are very far below those prevailing in Sweden. In the course of the statement the writer points out that the German worker receives Mk.60 a day, while the Swedish worker earns Kr.16, the equivalent of about Mk.230. German metal works pay Mk.340 per ton for coal, equalling Kr.23, while the Swedish industry is paying Kr.160 to Kr.180. The writer comes to the conclusion that it is necessary to protect the native industry by an effective import duty.—Reuter.

German Commercial Activity in China.—According to the *North China Daily News* the German engineer Kocher, who was recently nominated Director-General for the whole of China on behalf of the German electrical firm of Siemens, has contracted to supply the machinery necessary for the exploitation of a colliery near Hang Chow, in spite of the fact that Germany maintains her inability to manufacture such machinery for the restoration of the French coalfields. Moreover, Kocher has ordered from Germany a quantity of electrical tramway-factory equipment and other plant, severely undercutting English, French, and American products. Kocher was one of the most active German propagandists in China during the war, but thanks to the Chinese influence he was not repatriated.—Reuter.

German Locomotives for Russia.—The *Deutsche Allgemeine Zeitung* learns from the Linke-Hoffmann-Werke, which are taking a prominent part in the negotiations with the Soviet Government, that the announcements made by various Berlin papers as to a large order for locomotives placed in Germany by the Russian Government are premature. Nothing could be more inadvisable, say the works, than to create an impression in the shops that work on the Russian locomotives could be undertaken at once. The difficulties do not lie with the German locomotive works, which are in a position and ready to cover the Russian State's demand for locomotives, but are connected with the financial side of the business. The journal adds that it learns from the same source that a large order for special machines has just been received from England. It is, in any case, an encouraging fact, concludes the *Zeitung*, that England also places full confidence in the German machine industry.—Reuter.

New Companies.

Tillotsons Ltd. Private company.—Registered September 24th. Capital, £3,000 in £1 shares. To take over the business carried on at 52, Kennington Park Road, London, as "Tillotson Brothers," and to carry on the business of electrical, sanitary and hot-water engineers, manufacturers of electrical and mechanical instruments of all kinds, etc. The first directors are: S. G. Tillotson, C. R. Turner, R. N. Flint and H. Campbell. The two first-named are permanent. Secretary: S. G. Tillotson. Registered office: 52, Kennington Park Road, S.E.11.

Millo Co. Ltd. Private company.—Registered September 24th. Capital, £500 in £1 shares. Electricians, mechanical engineers, suppliers of electricty for light, heat, motive power or otherwise, etc. The permanent governing directors are: C. Milton (managing director) and F. Law. Registered office: 78, Deansgate Arcade, Manchester.

Samuel Warren Ltd. Private company.—Registered November 18th. Capital, £40,000 in £1 shares. To take over the business of Samuel Warren Ltd. (in liquidation), and to carry on the business of manufacturers, importers and exporters of iron and steel of all kinds, iron masters, smelters, etc. The first directors are: S. Warren, A. Cattell, J. Johnson and F. Chapman. Secretary: A. Cattell. Registered office: Speedwell Steelworks, Soho Street, Sheffield.

J. Matthews & Co. Ltd. Private company.—Registered November 18th. Capital, £5,000 in £1 shares. To take over the business of a mechanical and electrical engineer and iron and brass founder carried on by Joseph Matthews at 91 and 93, Northumberland Street, Liverpool, as "J. Matthews & Co." The first directors are: Joseph Matthews (governing director) and others to be appointed by the subscribers. Solicitors: G. B. Cummins, 11, Lord Street, Liverpool.

Callie & Co. (Liverpool) Ltd. Private company.—Registered November 18th. Capital, £4,000 in £1 shares. To carry on the business of welders by oxy-acetylene or other processes, metal stampers, manufacturers and repairers of motor engines, motor parts, aeroplanes, airships, etc. The subscribers are to appoint the first directors. Registered office: 20, North John Street, Liverpool.

H. G. Hawker Engineering Co. Ltd. Private company. Registered November 15th. Capital, £20,000 in £1 shares. To acquire from F. I. Bennett all the patents, rights, etc., relating to the manufacture of motor bicycles, and to carry on the business of manufacturers of and dealers in cycles of all kinds, internal-combustion and steam engines, motor cars, aircraft, etc. The first directors are: F. I. Bennett, H. G. Hawker, T. O. M. Sopwith, F. Sigrist and V. W. Eyre. Qualification, £500. Secretary: F. I. Bennett. Registered office: Canbury Park Road, Kingston-on-Thames.

Whitefield Foundry & Engineering Co. Ltd. Private company. —Registered November 15th. Capital, £5,000 in £1 shares. To carry on the business of coppersmiths, iron masters, engineers, founders, etc. The first directors are: J. Grieveson, W. H. Pickworth (managing director) and K. Mondey. Solicitor: P. F. C. T. Crow, 51, Frederick Street, Sunderland.

Combustion Developments Ltd. Private company.—Regis November 15th. Capital, £50,000 in £1 shares. To acquire any patents, etc., for improvements in burners for liquid fuel or any appliances for the storage, transmission or use of oil fuel or any other substances, liquids, gas or electric energy, etc., and to adopt an agreement with D. Wright, Sir Robert E. Chadwick, M.P., and F. S. Askew. The first directors are: Sir Robert B. Chadwick, Kt., M.P., F. S. Askew and D. Wright (all permanent, subject to holding 5,000 shares each). Registered office: 31, St. Mary Axe, E.C.3.

Northmapton Foundry Co. Ltd. Private company.—Registered November 15th. Capital, £10,000 in £1 shares. To carry on the business of founders, engineers, manufacturers of machinery or tools, etc., in Northampton or elsewhere. The first directors are: A. G. Whitlock, J. V. Collier and F. H. Thornton. Registered office: Balfour Road, Northampton.

Sandham Engineering Co. Ltd. Private company.—Registered November 19th. Capital, £5,000 in £1 shares. To adopt an agreement with P. H. C. Sandham and W. J. Connolly, and to carry on the business of manufacturers of side-cars for attachment to motor cycles, motor body hood and screen manufacturers and motor chassis builders, motor cycle and car manufacturers, general engineers, etc. The first directors are: P. H. C. Sandham and W. J. Connolly. Secretary: H. G. Bolton. Registered office: 336, Gray's Inn Road, W.C.

Mortgages, Charges, Satisfactions.

Wallace King Ltd.—Mortgage dated November 8th, 1920, to secure £4,000, charged on certain property in Mountergate Street, Norwich. Holder: F. Gowing, Hellesden, Norwich.

Pugh Engineering Co. Ltd (formerly Mechanical Transport and Development Syndicate Ltd.).—Mortgage dated November 22nd, 1920, to secure £750, charged on certain land at Addiscombe, Surrey. Holder: Lady Marion Noble, 13, Park Drive, Hampstead, N.W.

Triplock Ltd.—Debenture dated October 11th, 1920, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Latham, Hawthorndene, 59, Devonshire Road, Merton, Surrey.

St. Anthony's Foundry Ltd.—Particulars of £5,000 debentures, authorised November 7th, 1920, present issue £1,800, charged on the company's undertaking and property, present and future, including uncalled capital.

J. M. Gummerson & Co. Ltd.—G. Weston, of 10, Sutherland Avenue, Maida Vale, W., as receiver and/or manager on October 21st, under powers contained in debenture dated July 13th, 1920.

Fransquet Ltd.—E. F. Taylor, of 36, Homefield Road, Chiswick, as receiver on November 17th, under powers contained in debenture dated October 20th, 1920.

Lamson Pneumatic Tube Co. Ltd.—Deposit on October 21st, 1920, of deeds of certain property in Hythe Road, Hammersmith, to secure all moneys due or to become due from company to Barclay's Bank Ltd.

Foundries Ltd.—Issue on October 14th, 1920, of £200 debentures part of a series already registered.

Lever Manufacturing Co. Ltd.—First mortgage debenture dated October 30th, 1920, to secure all moneys due or to become due from company to Manchester & County Bank Ltd., charged on the company's undertaking and property, present and future, including uncalled capital.

Bromley, Fisher & Turton Ltd.—Satisfaction in full on October 26th, 1920, of debenture dated April 7th, 1900, securing £2,500, of which £2,029 2s. 1d. was outstanding on July 1st, 1908.

J. C. H. Martin Ltd.—Equitable mortgage dated October 20th, 1920, to secure all moneys due or to become due from company to Barclay's Bank Ltd., charged on certain properties in Lewes.

G. R. Turner Ltd.—Debenture dated October 29th, 1920, to secure £25,000, charged on the company's undertaking and property, present and future, including uncalled capital (subject to existing debentures £50,000). Holders: H. Holford and J. Smith, 3, Beastmarket Hill, Nottingham.

A. Ransome & Co. Ltd.—Debenture dated October 28th, 1920, to secure £14,000, charged on the company's undertaking and property, present and future, including uncalled capital (if any). Holders: Underfeed Stoker Co. Ltd., Coventry House, South Place, Finsbury, E.C.

Benton & Stone Ltd.—Debenture dated November 5th, 1920, to secure £20,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to existing mortgages and charges and ranking *pari passu* with outstanding debentures of £10,500. Holders: Barclay's Bank Ltd.

Henry Walker & Son Ltd.—Satisfaction in full on November 12th, 1920, of mortgage dated August 23rd, 1920, securing £500.

Whittaker Bros. (Accrington) Ltd.—Mortgage dated September 11th, 1920, to secure £2,000, charged on certain land and premises, etc., in Accrington. Holder: M. Thompson, Fairhaven, Lancs.

Kennish & Co. Ltd.—Mortgage dated November 1st, 1920, to secure £300, charged on certain land and buildings, near Cross Lane, Salford, except mines and minerals thereunder. Holder: W. Kennish, 13, North Avenue, Burnage Garden Village, Levenshulme, Manchester.

Darlington Rolling Mills Co. Ltd. Satisfaction in full on October 5th, 1920, of debenture stock dated March 4th, 1910, securing £30,000.

Alfred Dugdale Ltd.—Single part mortgage debenture dated November 15th, 1920, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders: G. Inskipp and C. M. Jeram, 190–192, Great Portland Street, W.

Willans & Robinson Ltd. Satisfaction in full on February 9, 1920, on debentures dated December 20th, 1911, and April 28th, 1916, securing £40,000 and £20,000 respectively.

Laminated Gears Ltd.—Issue on November 23rd, 1920, of £600 debentures, part of a series.

Patent Applications.

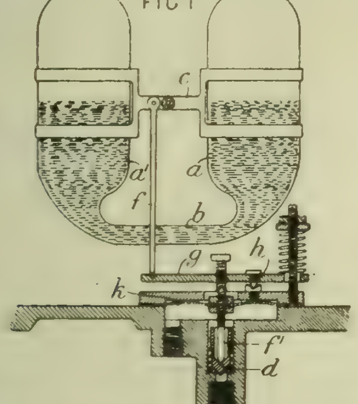
ABSTRACTS OF SPECIFICATIONS.

The following Abstracts of Specifications are brought up to the latest date possible, and are abstracted from the Illustrated Official Journal of Patents, which is published weekly.

VALVES; THERMAL SWITCHES.

133,147.—F. E. LAMPLOUGH, and H. J. SCOTT, Lighthouse Works, Smethwick, Staffordshire.—Oct. 2nd, 1918.—A valve-actuating device controlled by solar radiations comprises a pair of chambers containing saturated vapour in contact with its liquid, or a gas in contact with its saturated solution, adapted to actuate the valve or to actuate a switch controlling an electrically-operated valve. In the form shown, the liquid and vapour is sealed in two glass vessels *a*, *a*1 joined by a narrow neck *b* and mounted in a cradle *c*. The vessel *a* is blackened externally, while the vessel *a*1 is plain or silvered and fitted with a guard, so that when acted on by solar radiations, the mass of vapour increases by evaporation in one chamber and decreases by condensation in the other, the resulting pressure difference moving a volume of liquid from

FIG 1

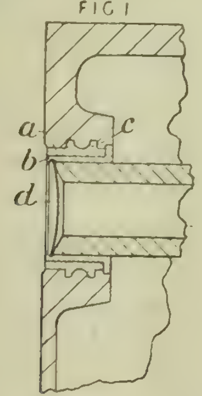


one chamber to the other to tilt the cradle. A check valve may be fitted to prevent excessive transference of liquid. In a modification, a volume of liquid is arranged in each chamber above a volume of mercury. In this form, the chamber *a*1 is formed with a blackened extension to prevent the entire disappearance of the vapour phase. The cradle *c* is connected to the gas-valve *d* through a strut *f*, a spring-loaded lever *g* supported on a knife-edge *h*, and a strut *f*1 fitted with a packing diaphragm *k*. In a modification, the valve is directly mounted on the lever *g*. To prevent excessive movement of the cradle during summer weather, a bimetallic strip may be fitted tending to tilt the cradle in the opposite direction when a large increase of pressure takes place.

PISTONS.

133,282.—R. ALLEN, Chiltern Rise, Woodcote, Reading, Berkshire.—June 27th, 1919.—A gudgeon-pin bearing fitted into a piston of aluminium alloy or other metal consists of a sleeve *a* which is either cast in position or pressed into the hot piston and secured by contraction, and an inner hardened flange bush *b*

FIG 1

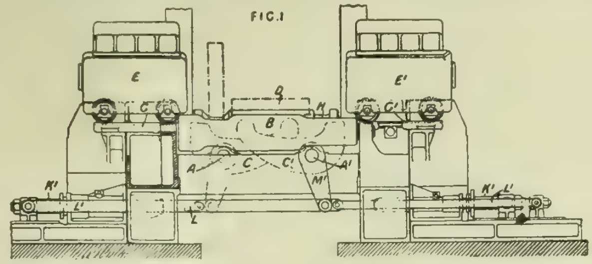


fitting accurately into the sleeve *a*. To prevent scoring of the cylinder by the ends of the gudgeon-pin, a soft-metal disc *d* slit at its edge is sprung into an annular groove at the end of the bush *b* or of the sleeve *a*. When the sleeve *a* is cast into the piston it is provided with anchoring ribs or projections *c*. The disc *d* may be replaced by a strip with rounded ends.

ROLLING METALS.

133,197.—A. LAMBERTON, Sunnyside Engine Works, Coatbridge, Lanarkshire.—Oct. 30th, 1918.—A rolling-mill for slabs, blooms, etc., has one or more rocking shafts A, A′, placed at right-angles

FIG.1

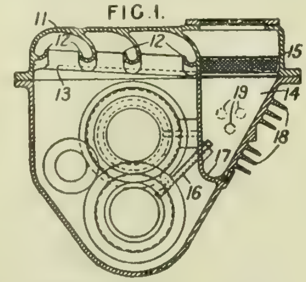


to the feed-rolls B and main rolls, each carrying two double-armed levers C, C′ working in spaces between the feed rolls to turn the slab D into the desired position, and preferably operated by hydraulic cylinder K′, links L, L′, and cranks M, M′, placed at the end of the shafts A, A′, away from the heat and debris of the pass. Carriages E, E′, sliding on rails G, G′, assist in positioning and guiding the slabs to the various passes H.

LUBRICATING.

133,251.—F. B. SHAW, 33, West Heath Drive, Hampstead, and H. M. BONNAUD, 132A, Brixton Hill, both in London.—Mar. 15th, 1919.—A gear box is provided with a secondary chamber for cooling and straining the lubricant. Oil thrown up by toothed gears,

FIG.1.

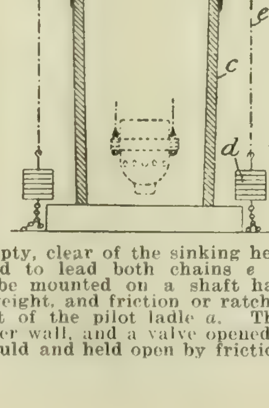


etc., is caught by inclined ledges 12 formed on the cover of the gear box, and passes through inclined side channels 13 and through a filter 15 to a chamber 14, in which the oil is cooled by means of fins 18 and/or internal tubes 19. The outlet 16 from the chamber 14 may deliver direct on to the gear wheels, and is placed above the bottom of the chamber leaving a sump in which sediment accumulates.

CASTING METALS.

133,117.—H. H. HOSACK, 145, Richmond Road, Twickenham, Middlesex.—Aug. 29th, 1918.—In pouring molten steel or other metal into ingot or like moulds, splashing and consequent oxidation of the metal is minimised by employing a subsidiary ladle *a* fed from the main ladle *b* and suspended during operation at the surface of the cast metal in the mould *c*. To ensure slow cooling of the upper portion of the ingot, a vacuum hood *g* may be employed. Balance weights *d* attached to chains *e* keep the

FIG.1.



ladle *a*, when empty, clear of the sinking head *i*. The pulleys *f* may be arranged to lead both chains *e* to a single balance weight, or may be mounted on a shaft having a third pulley for the balance weight, and friction or ratchet controlling means for the movement of the pilot ladle *a*. The ladle *a* may have an inner and outer wall, and a valve opened by contact with the bottom of the mould and held open by friction or by a catch.

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